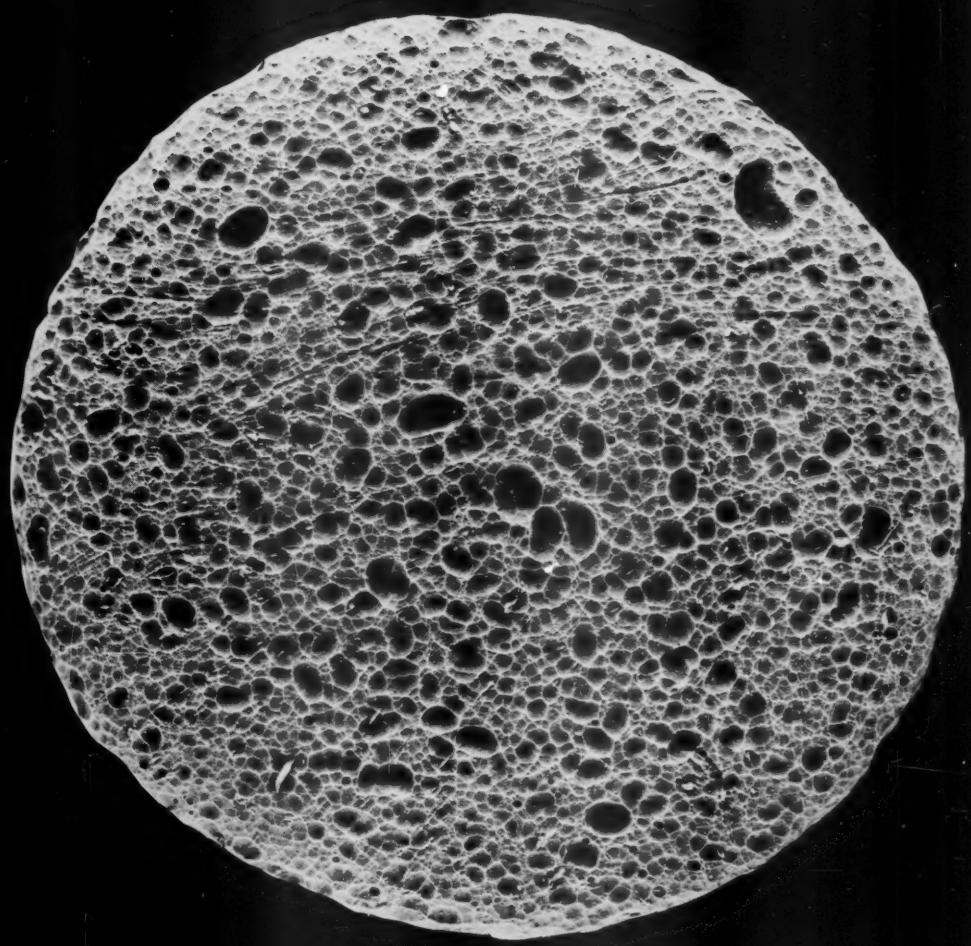
SCIENCE

24 February 1961

Vol. 133, No. 3452

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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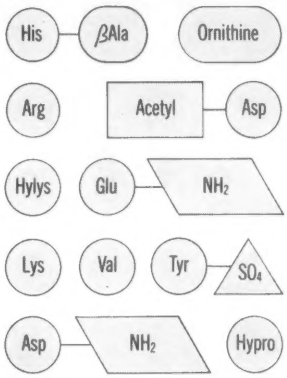

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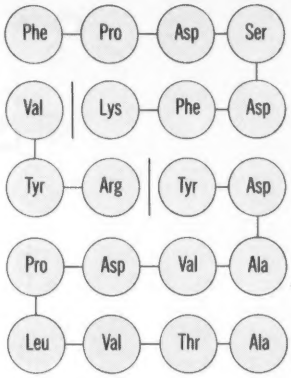

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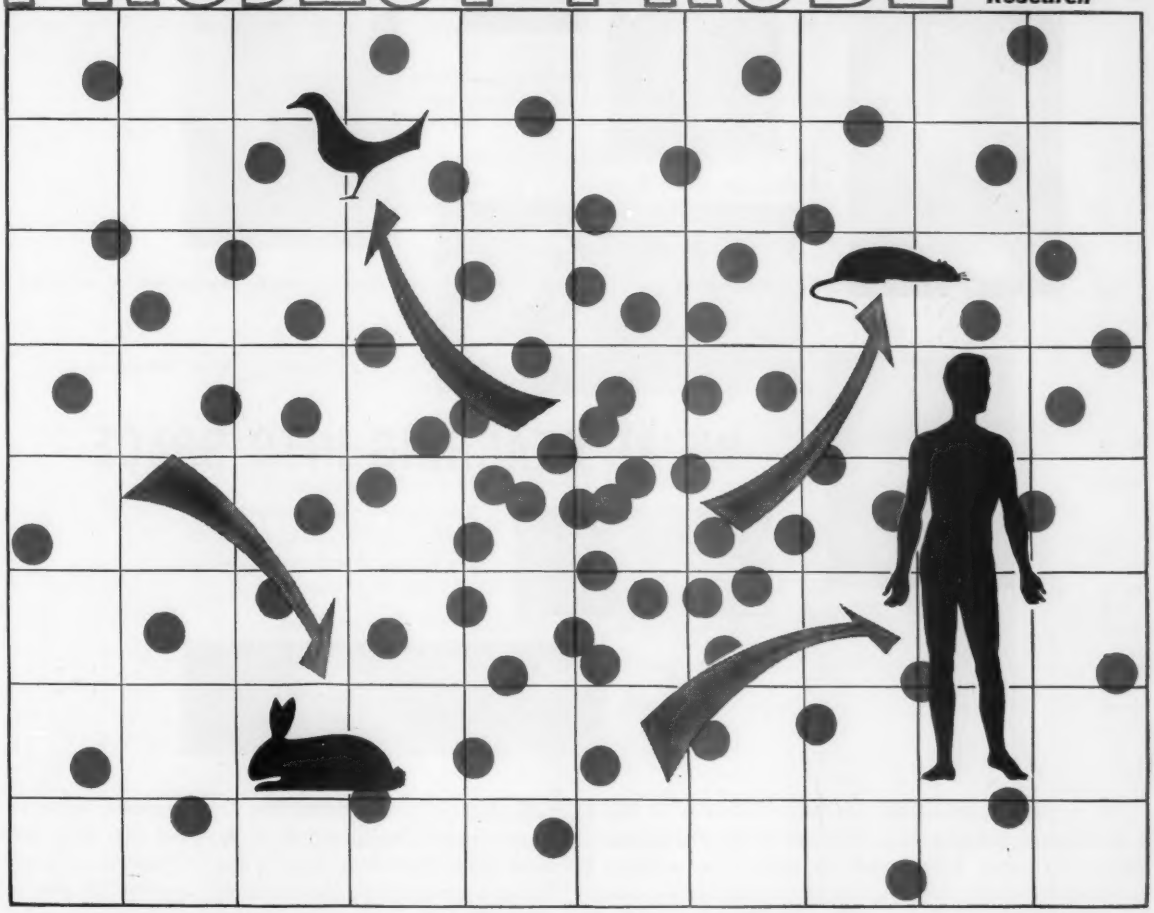

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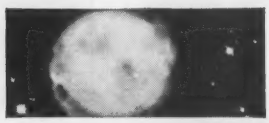
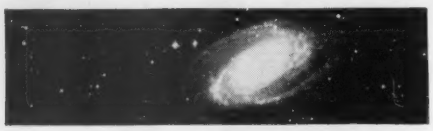


Bell Laboratories research with chilled ruby amplifiers speeds the day we may telephone via satellites



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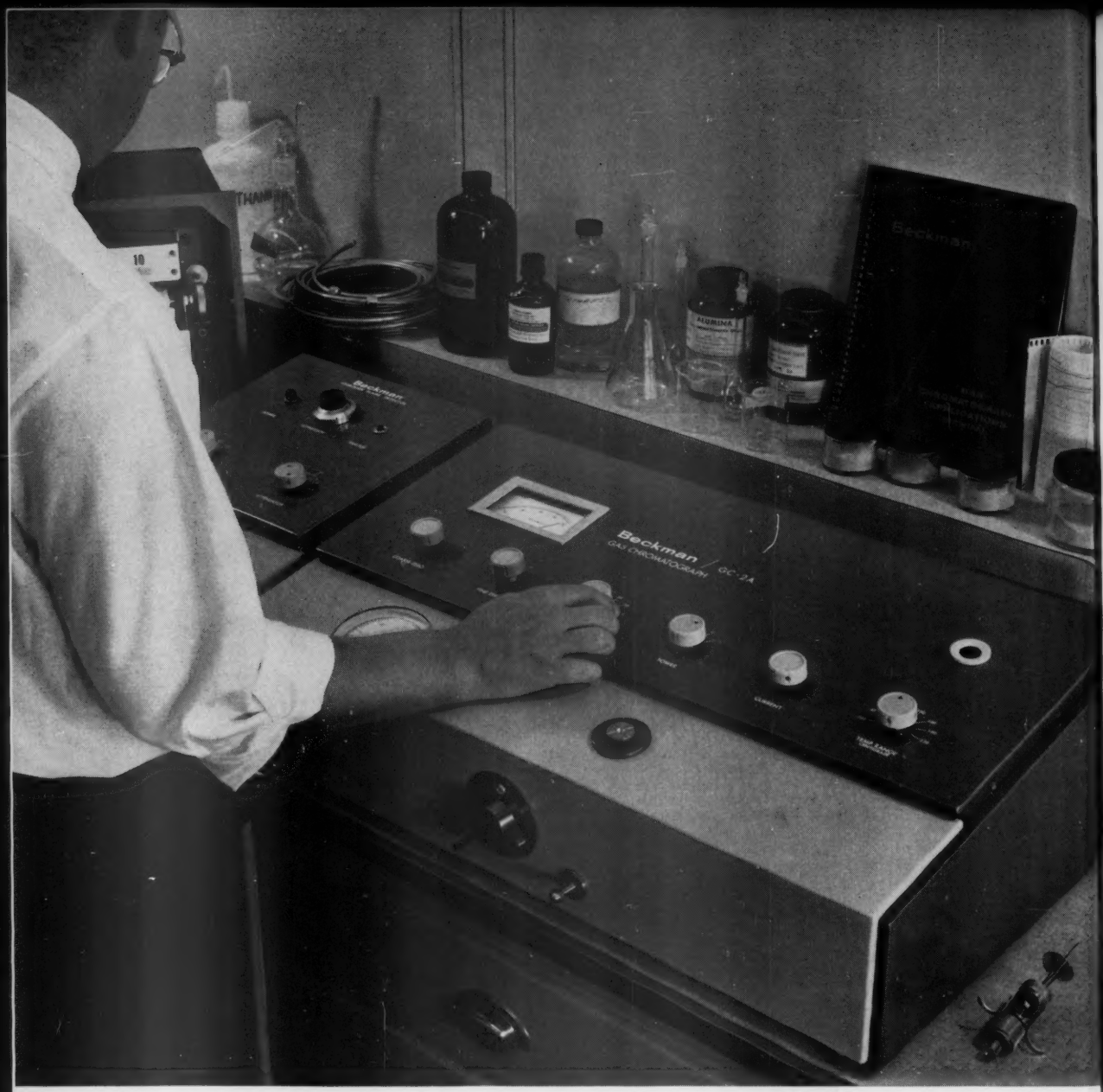
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

24 February 1961, Volume 133, Number 3452

SCIENCE

Cover

Tektite found in 1955 about 3 miles southwest of Osierfield, Ga., now in the Museum of the Georgia Geological Survey, Atlanta. The specimen, which measures 4.7 by 4.4 by 0.6 centimeters and weighs 17.8 grams, was smoked with ammonium chloride to bring out surface details. See page 562. [U.S. National Musueum, Washington, D.C.]



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[1] L. Cranberg, *et. al., to be presented at Am. Phys. Soc. Meeting, New York (February 1961)*

[2] R. C. Mobley, *Phys. Rev.* 88, 360 (1952)

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SCIENCE

SCIENCE, now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at National Publishing Company, Washington, D.C. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

Editorial correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, see *Science* 125, 16 (4 Jan. 1957).

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"Neither snow nor rain nor . . ."

Since 1940 the Bureau of Customs and the Post Office have been impounding mail deemed to be foreign political propaganda. During World War II millions of pieces of mail were impounded and destroyed without notification to those to whom it was addressed. In 1946 the program virtually lapsed, only to be resumed in 1950 when propaganda began to increase with the onset of the Korean War. During the early '50's the policy of not notifying addressees was continued; propaganda was so loosely defined that even works on art, philosophy, and religion, some 19th-century literature, and some scientific and scholarly journals were destroyed. Research libraries, bookstores, and individuals often did not receive books that they had ordered or journals that they had subscribed to.

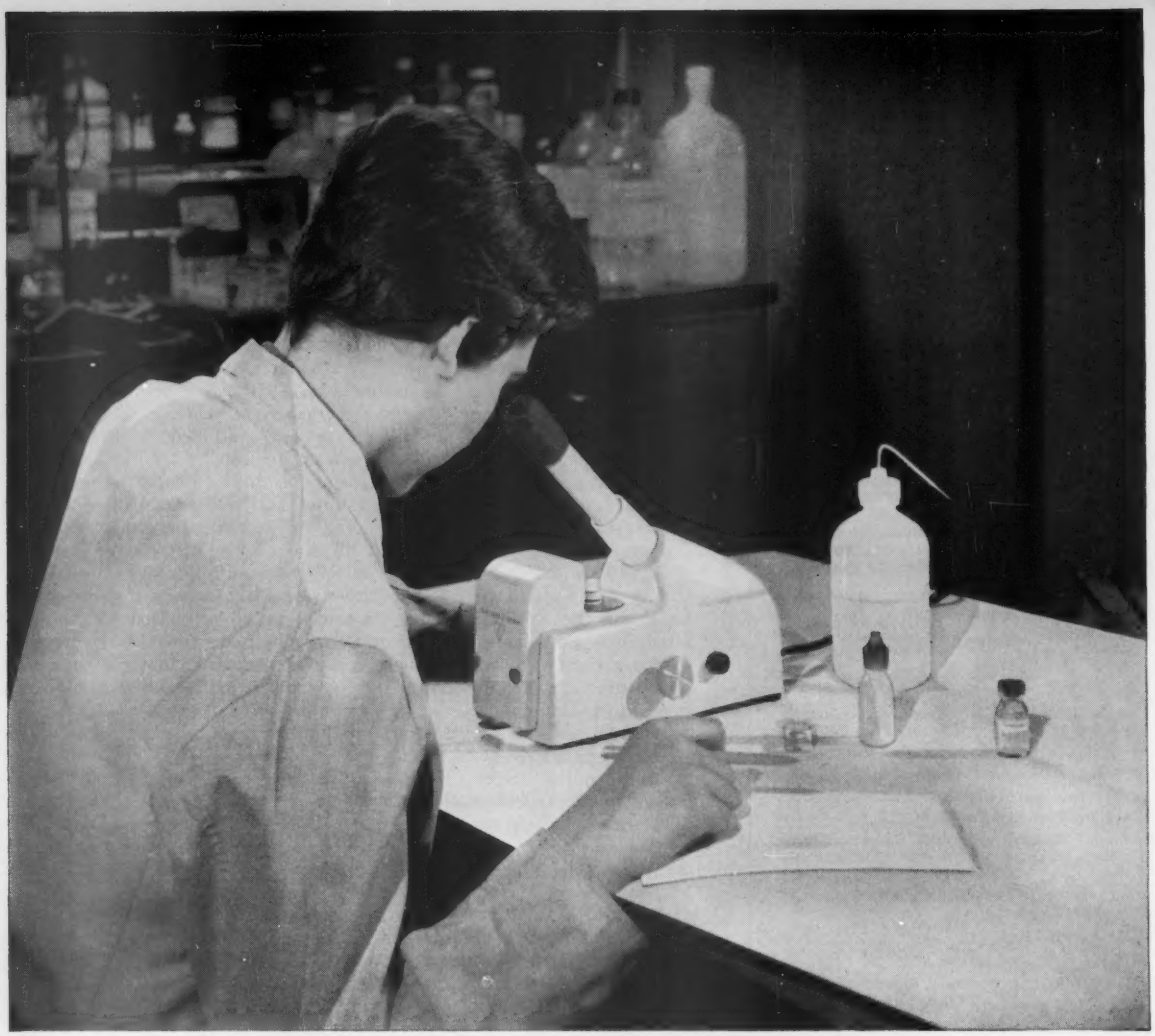
By 1955, research libraries, universities, and specialists in Asiatic studies had applied enough pressure to persuade administrators in Customs and the Post Office that they had a scholarly need for the materials that were being delayed or destroyed. Accordingly, a "white list" of those eligible to receive such mail was prepared. Material addressed to a professor at his university address would be delivered; that addressed to his home, impounded.

In 1958 the Post Office adopted the policy (still in effect) of notifying all addressees that it was holding mail containing foreign political propaganda—material which, though ordinarily nonmailable, would be delivered to the addressee provided it "has been ordered, subscribed to, or desired, and is not for dissemination." To receive the material the addressee must sign a statement that he has ordered, subscribed to, or desires the publications listed. And what is meant by "dissemination"? Read by two people? Available in a library? Referred to in an article? No one knows.

Still more remarkable, the entire program, from its inception, has had no statutory basis. Congress has passed no law giving the Bureau of Customs or the Post Office the right to impound, destroy, or delay delivery of mail. The legal basis is a 1940 ruling by the Attorney General that depends upon a strained interpretation of two statutes. A *nonregistered* foreign agent resident in the U.S. would violate the Foreign Agents Registration Act of 1938. He would thus also be violating the provision of the Espionage Act of 1917 that makes it a criminal offense for anyone "in aid of any foreign government" to have or control papers to be used in violating any penal statute. Such papers are nonmailable under the Espionage Act. The Attorney General then ruled that foreigners in foreign countries who used our mails for transmitting propaganda became *unregistered foreign agents here*, and that their papers were therefore unmailable. If taken literally, this means that the clerk who mails an issue of the London *Times* that contains an editorial distasteful to a U.S. customs or postal official could be regarded as an unregistered foreign agent and the issue could be impounded.

During the two decades in which this legal fiction has been used to justify censorship, numerous efforts have been made to get a court test, but the challenges have so far been successfully evaded. In general, threat of a suit has been sufficient to bring about delivery of the material. But three suits are now pending in the District of Columbia, and it is encouraging that the Department of Justice has asked for an extension of time to permit it to review the entire question.

Regardless of the outcome in these cases, we hope that Congress will review the program and come up with some legislation that will protect the traditional freedom of a citizen in a democracy to decide for himself what to read without having to sign a document, and that will not put him in jeopardy if he "disseminates" what he has read.—G.DuS.



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INSTRUMENTS AND TECHNIQUES

Viruses and Tumors

The electron microscope is proving to be a powerful tool for study of viruses and virus-induced tumors.

Leon Dmochowski

There exists a striking similarity between the progress made during the last 10 years in the studies on viruses as causative agents of infectious diseases in man and the advances in the studies on viruses implicated in the origin of tumors in animals. During this time more than 150 new infectious viruses have been described, and a number of viruses have been found responsible for various types of tumors in animals. The progress made in the discovery of these new viruses has largely been due to the use of newborn animals, improvements in tissue culture methods, and the introduction of the electron microscope as a tool for study of the submicroscopic structure, first of normal and then of cancerous cells, and later of viruses themselves.

Viruses and Cells: Present-Day Definition and Relationship

There is an intimate association between viruses and cells. Both cells and viruses have the ability to reproduce themselves, but the latter can only reproduce within cells. Viruses are nucleoprotein entities with one type of nucleic acid (ribo- or deoxyribonucleic acid); they are infectious (that is, capable of entering suitable susceptible cells); they reproduce from their own genetic material within the cells they infect; as a by-product of their reproduction within cells they may, but need not, induce a disease; they are unable to grow and divide; and they contain no enzymes (*1*).

As is discussed below, this definition of viruses has been confirmed by electron-miscroscope and biochemical studies. When a virus enters a cell, part or all of the metabolism of the cell is used for the manufacture of the virus. During this manufacturing process the cell may not show any visible signs of the entry and reproduction of the virus, but it may frequently be impaired in its various functions or even destroyed. This latter symptom of viral entry into the cell, described as cytopathic effect, has been successfully utilized in modern tissue-culture methods as a means of isolating and identifying many newly discovered infectious, and also tumor-inducing, viruses. It should be mentioned that the classification of viruses into "infectious" and "tumor-inducing" is misleading. It has lead to an artificial division of viruses into two seemingly unrelated types: "ordinary," or "infectious," and "tumor-inducing" viruses. It is now known that tumor viruses have all the properties of ordinary viruses (*2*) and that the latter may be implicated in the origin of cancer (*3*). There is no doubt now that certain viruses, following entry into suitable susceptible cells, lead to continuous, unrestricted proliferation of the cells and therefore to malignant or cancerous behavior in the organism of the host. Similar activity of the Rous sarcoma (*4*) and the SE polyoma virus (*5*) has recently been demonstrated in suitable susceptible cells grown in tissue culture. Thus, a virus may transform a normal cell into a cancer cell both in an animal and when maintained outside the body of the animal. It is now known that the same virus may lead to inflammatory and destructive changes in certain cells and to malignant proliferation of other cells, as shown in the case of the SE polyoma virus (*6*).

This manifold ability of a virus to enter a cell and destroy it or change it into a cancer cell may lead to the question, Is virus "alive," and if so, is it the smallest unit of life? This philosophical question is as difficult to answer as the question, What is life? Life is a process, and it is therefore hard to define a virus, a cell, or any cell constituent as a unit of life, no matter how small the virus or cell constituent may be. Recent advances in biochemistry have shown that nucleic acid, which is a virus constituent, is capable of inducing changes characteristic of the particular virus (*7*) and is therefore a carrier of viral activity. Furthermore, nucleic acid of a virus is capable of entering cells not susceptible to the virus in which the nucleic acid originated and of reproducing the virus within such cells (*8*). It would, however, be a mistake to relegate the complete virus to a purely secondary role or to ascribe to a cell only a secondary importance in favor of its nucleus. A cell with its nucleus and a virus with its nucleic acid represent an entity in each case, as in turn a cell infected with a virus may represent an entity (*8*).

Viruses and Cancer in Animals and Man

It is well known today that many types of cancer in animals are induced by viruses. There is, as yet, no experimental proof available that any one type of human cancer is induced by a virus. It would, however, be strange if nature were to impose such limits between the animal kingdom and man, or

The author is chief of the virology and electron microscopy section of the University of Texas M. D. Anderson Hospital and Tumor Institute and clinical professor of microbiology, Baylor University College of Medicine, Houston, Tex. This article is adapted from a lecture delivered 29 December 1959 at the annual meeting of the AAAS, in Chicago.

to divide so sharply the origin of cancer in animals from that of cancer in man. Studies of tumor-inducing viruses do indicate the possibility that at least some human cancers may be of viral origin.

Human cancer, like animal cancer, develops from a wide range of types of cells in any part of the body. It is also known that diverse factors may be responsible for the many types of cancer in different parts of the animal body. But an analysis of the different cancerogenic factors reveals a certain repetition of pattern, with emphasis on one or more factors, in any type of cancer. Thus, genetic, hormonal, and metabolic factors, and environmental factors such as various chemical carcinogens, radiation energy, and viruses, form a chain of events which leads to the formation of cancer. It is already known that in a number of virus-induced cancers in animals the genetic constitution and hormonal factors prepare a suitable background for the action of the virus, leading to the induction of cancer. Without these factors, the virus itself is almost powerless. However, frequently large amounts of virus may overcome low genetic susceptibility, which in turn leads to a less favorable hormonal environment.

In the case of some animal tumors, the same virus may induce as many as 23 different types of cancer in different parts of the body of the animal (mouse) and also different types of cancer in animals of several other species (*9*). The list of viruses responsible for animal cancers is constantly growing, especially since the discovery of the viral origin of a certain (lymphatic) type of leukemia in mice by Gross (*10*). The induction of tumors in animals which had been inoculated, when newborn, with extracts of tumor tissues filtered through cell- and bacteria-retaining filters, or with tumor extracts which had been passaged repeatedly in tissue culture, has led to various interpretations of the observed and confirmed experimental facts. The concept of a process similar to transduction or transformation in bacteria was introduced as a possible basis for the induction of tumors (*11*). In another interpretation, the concept of an antigen-bearing particle specifically interfering with the immunity-producing system of mice was put forward (*12*). Electron microscopy of ultrathin sections of tumor tissues and of various preparations obtained from tumors induced by cell-free preparations has, however, demonstrated that tumor-inducing agents have a morphological basis. It appears that electron microscopy may help us to understand the chemical basis of viral activity and contribute to our knowledge of the structure of tumor viruses and of their mode of activity within cells.

Biological experiments recently carried out have revealed the existence of yet another relationship of tumor viruses to cells. Extracts of organs from normal mice have been shown to induce tumors in other mice (*13*). Treatment of apparently normal mice with cortisone has led to the development of tumors, known to be of viral origin (*14*). X-irradiation of mice with a low incidence of leukemia has induced leukemia in these animals, which could then be transmitted by cell-free extracts to other animals of the same strain (*15*). Morphological studies carried out by means of the electron microscope have shown the presence of virus particles in cells of animals in which leukemia was induced by the cell-free extracts from tissues of mice that became leukemic after x-irradiation (*16*).

These experiments have demonstrated that some tumor viruses may exist in animals in a latent form without inducing cancer or leukemia. These viruses may be transmitted from generation to generation without any symptoms and thus appear noninfectious in the ordinary sense. Tumor viruses, however, may also spread, like any other virus, through contact between animals or in animal secretions and excreta (see *17*).

Ultrastructure of Normal and Virus-Infected Cells

Electron-microscope studies have supplied much detail on cell components known to exist from studies in the light microscope. They have led to the discovery of new constituents in cells and have clarified our knowledge of other controversial constituents. The appearance of cells processed for electron microscopy compares favorably with that of living cells seen by phase contrast microscopy.

There exists an amazing similarity, as revealed in electron-microscope studies, between the submicroscopic structure of plant, animal, and human cells. At least some plant cells have the same cellular constituents as animal cells and are of similar structure (*18*). Similarly, in type and structure of submicroscopic constituents, no differences between animal and human cells have been observed (*19*).

After normal cells had been studied through electron microscopy, the study of cells during various diseases, especially viral infections, was undertaken. This has led to the visualization of viruses in the infected tissues and has revealed the complicated structure of these agents and the behavior of various submicroscopic cell elements during the different stages of infection (*20–22*). Electron microscopy has revealed a basic similarity in the appearance and internal structure of bacterial, plant, animal, and human viruses, as seen in the infected cells. Although these viruses may vary in size and shape and in some details of internal structure, they show a common basic structure—a protein envelope or envelopes and an internal dense center, now known to be the nucleic acid (*22, 23*). Constant improvements in staining techniques have recently led to the visualization of structural organization of the different components of plant, animal, and human viruses, isolated from the infected cells (*24*).

Electron microscopy of ultrathin sections of cells infected with viruses has given us a picture of these subcellular particles in their natural surroundings. The complicated structure of the virus particles helps in differentiating these particles from normal cell components. It appears that we are gradually acquiring an understanding of the structure of virus particles both within and outside the infected cells.

Ultrastructure of Cancer Cells

Soon after the application of electron microscopy to cytology of normal and infected cells, electron-microscope studies of malignant cells were started. Particular attention was directed toward tumors of known viral origin (*22, 23*). The comparative ease with which viral agents could be detected in the diseased tissues and in some tumors of known viral origin also led to electron-microscope studies of tumors suspected to be or viral origin.

Electron-microcsope studies of cancer cells have, so far, failed to reveal any essential differences between the submicroscopic structure of cancer cells and that of normal cells (*22, 23, 25*).

Cancer cells from tumors of viral origin have, however, shown various degenerative changes in their ultrastructural components and have shown structural components now known to be virus particles. The changes in the various cellular components, such as Golgi apparatus, mitochondria, endoplasmic reticulum, and nuclear and cell membranes, if not directly related to the development of virus particles, could be described as nonspecific, as these changes have also been observed in cells subjected to various unfavorable environmental influences. An analysis of the changes which can be specifically related to the development of virus particles within cancer cells reveals a striking similarity to the changes observed in cells infected with various "ordinary" or "infectious" viruses, whether plant (*26*), animal, or human (*22*, *23*). It represents a morphological confirmation of the similarity in biological behavior of infectious and tumor-inducing viruses. Electron microscopy of tumor cells of viral origin has also revealed a basic similarity between virus-induced tumor cells in amphibia, birds, and mammals and similarity between the virus particles observed within these cells.

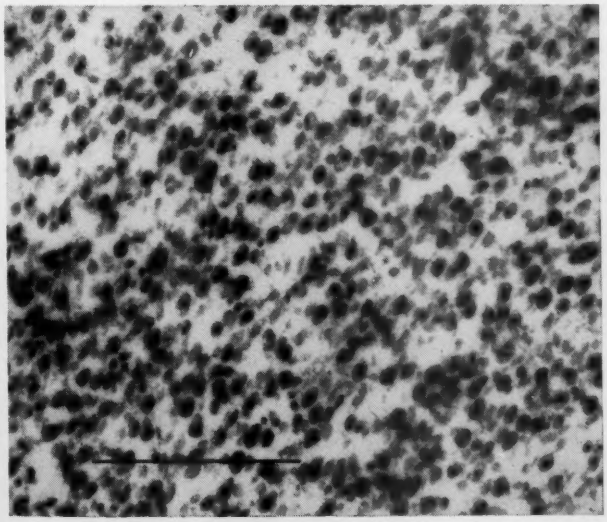
Detection of Virus Particles in Cancer Cells

Any description of the various changes observed in cancer cells would be incomplete without mention of the difficulties encountered in the search for virus particles in electron-microscope studies of tumors of known viral origin. This point is of extreme importance to any future studies of human cancer of unknown or suspected viral etiology.

In some virus-induced tumors, the large size of the etiological agent alone, or this factor combined with the high infectivity of the tumor extracts, has helped considerably in the detection of virus particles in the tumor cells. The Shope fibroma in rabbits (*27*) and molluscum contagiosum in man (*28*) are tumors caused by viruses of the pox group. Further electron-microscope studies on these viruses may perhaps demonstrate a connection between pox infections and some types of cancer. It should not be forgotten that the hypothesis of the viral origin of cancer was first put forward by Borrel and Bosc in 1903 (*29*), who observed the proliferative effect of pox viruses on tissues. This hypothesis was advanced before the discovery of the first tumor of viral origin—that is, chicken leukosis—by Ellermann and Bang in 1908 (*30*).

In cells of organs of chickens suffering from different forms of the so-called chicken leukosis complex, such as visceral lymphomatosis, erythroblastosis, and myeloblastosis, the presence of viral particles was detected with comparative ease, as one cell in 50 or one in 100 revealed the particles (*22*). However, the search for virus particles in the circulating blood cells of chickens with fowl leukosis was found to be extremely difficult and mostly unsuccessful (*31*). This may be an indication that in cancer affecting blood, the circulating blood cells, which would appear to be the natural target of a search for virus particles by means of the electron microscope (*32*), are not the choice material for morphological proof of viral etiology. This apparently is the case at least in certain types of cancer of the blood, not only in chickens but also in mice. This may also indicate an approach in electron-microscope studies of cancer of the blood (leukemia) in man.

Other chicken tumors of known viral origin may serve as an example of the difficulties encountered in the search for viral particles. It was many years



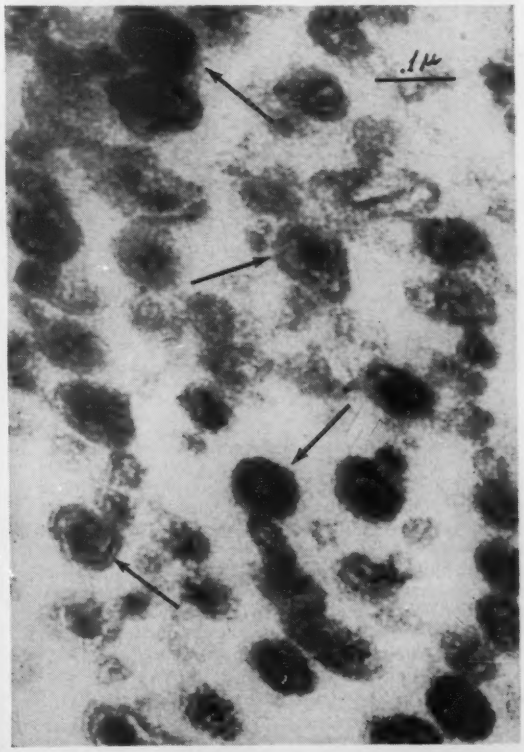


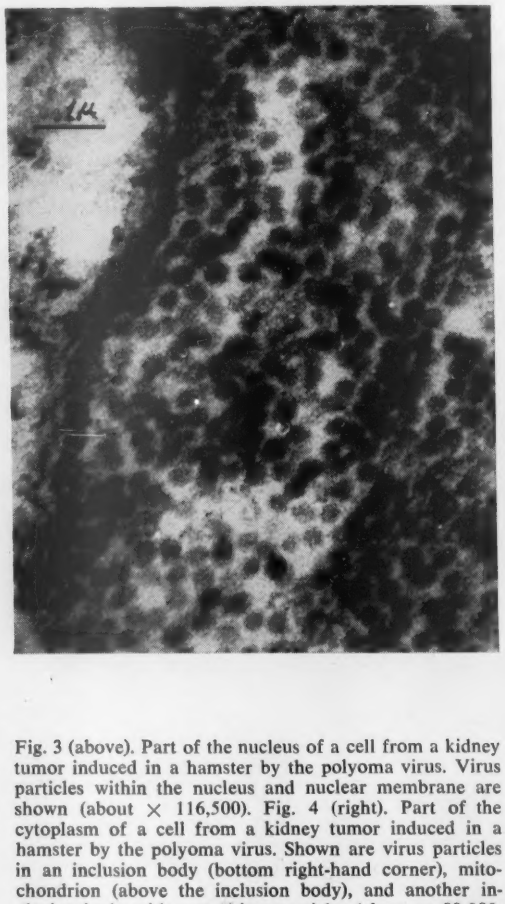
Fig. 1 (above). General appearance of virus particles in a pellet obtained by differential low- and high-speed centrifugation of milk from mice of virus-carrying strains, following defatting, decasemination, and fluorocarbon treatment (about × 32,000). Fig. 2 (right). Part of Fig. 1 at higher magnification (about × 134,000). The arrows point out virus particles, showing some details of internal structure. [L. Dmochowski, C. E. Grey, L. O. Pearson, R. G. Hughes]

before characteristic virus particles were discovered in the chicken tumor called Rous sarcoma (after the discoverer of the viral origin of this tumor). In spite of improved techniques, the search for virus particles in this and other chicken tumors of connective and endothelial tissues, although successful, has been difficult and time-consuming because of the small number of virus particles found, although biological proof of the viral origin of these tumors has been available for some time (*33*).

Although the viral origin of breast cancer in mice was conclusively shown by Bittner in 1936 (*34*), characteristic virus particles were not found in cells of these tumors until 1954 (*35*). Since then, the search for the morphologically characteristic agent in the cells of at least some breast cancers in certain strains of mice has presented comparatively little difficulty (*36*). It was soon found that this was not by any means the rule. Cells of breast cancers in mice from different strains showed considerable variation in the number of virus particles observed. In some breast tumors virus particles could not be found, although occasionally the agent could be demonstrated biologically (*37*). It was later shown that by certain chemical and biophysical procedures the agent can be concentrated and demonstrated both biologically and in the electron microscope (*38*) (Figs. 1 and 2). The part played by electron microscopy in the isolation and purification of tumor virus is discussed below.

After the discovery of cell-free transmission of lymphatic leukemia in mice (*10*), the presence of characteristic virus particles both within and outside the cells was demonstrated in 1956 (*39*). These particles could not be demonstrated in every case of leukemia in mice, and only after considerable search could they be found within cells (*40*). In spite of ample experimental evidence of the viral origin of this type of leukemia in mice (*17*), the demonstration of virus particles in this type of cancer is far from an easy one, as they can only be found in approximately one-third of the examined cases. This morphological finding coincides roughly with the results of bioassays for the presence of leukemia-inducing virus in leukemic tissues of mice with lymphatic leukemia (*41*).

During attempts at confirmation of the concept of cell-free transmission of mouse lymphatic leukemia, tissue-cul-



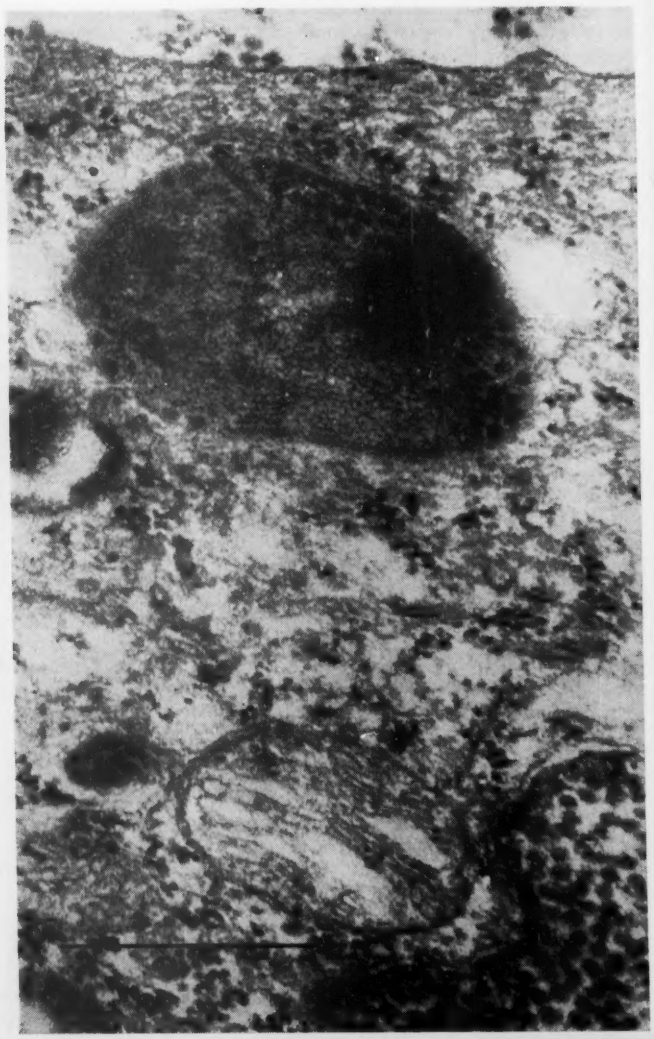


Fig. 3 (above). Part of the nucleus of a cell from a kidney tumor induced in a hamster by the polyoma virus. Virus particles within the nucleus and nuclear membrane are shown (about × 116,500). Fig. 4 (right). Part of the cytoplasm of a cell from a kidney tumor induced in a hamster by the polyoma virus. Shown are virus particles in an inclusion body (bottom right-hand corner), mitochondrion (above the inclusion body), and another inclusion body with some virus particles (about × 89,000; measure, 0.5μ). [L. Dmochowski, C. E. Grey, E. Bereczky, J. Blicharski]

ture studies resulted in the discovery of another tumor-inducing virus, the so-called polyoma, a virus inducing multiple tumors in mice, rats, and hamsters (*9*, *42*). This discovery immediately raised the question of whether one or more viruses are involved in the origin of these tumors. Evidence was eventually obtained, in suitable biological experiments, that one virus is the etiological agents of all these cancers (*9*). This observation required morphological confirmation which at first could not be readily obtained. The destructive changes induced by polyoma virus are easily observed in cells grown in tissue culture. Electron-microscope examination of cells showing these changes demonstrated with comparative ease the presence of characteristic virus particles, mostly in the nucleus and occasionally in the cytoplasm of the infected cells (*43*). Similar results were obtained with different types of cells grown in tissue culture (*44*). Thus, there was no difficulty in demonstrating characteristic virus particles—apparently the etiological agent—in the destructive lesions. Moreover, these particles could be shown with a remarkable consistency.

An entirely different problem, however, arose in the examination of cancers induced in animals by the polyoma virus. The virus particles were found only after an intensive and prolonged search in polyoma-induced cancer of the breast (*43*) and in salivary glands of mice (*43*, *45*) (Figs. 3–5). This in itself was not surprising in view of the already known difficulty in obtaining biologically active extracts of these tumors (*9*). The presence of the virus in polyoma-induced tumors could be demonstrated in biological tests such as passage of extracts of the tumor cells on embryo cells grown in tissue culture (*9*) or by growing the tumor cells in vitro (*46*). Thus, again, a certain correlation has been observed between the presence of characteristic virus particles in tumor cells and the presence of tumor-inducing activity in these cells.

In an extensive electron-microscope study of kidneys from polyoma-infected mice, rats, and hamsters, virus particles, similar to those observed in polyoma-infected cells in tissue culture, have been found in the nuclei and occasionally in the cytoplasm of the cells of proximal and distal convoluted tubules and in the cells of the collecting tubules of kidneys from animals of the three species (*47*). These particles have been found with decreasing frequency in the cells of proliferative lesions, and only with great difficulty in the neoplastic changes in the kidneys of these animals (*47*, *48*). Further studies of polyoma-induced tumors in the kidneys of mice, rats, and hamsters have revealed virus particles in the nuclei of cells of the tumors (*49*) similar to those reported in the cells of kidneys with inflammatory, destructive, and proliferative lesions. Again, electron-microscope studies amply indicate the difficulties encountered in the search for virus particles, even in tumors of known viral origin. In view of the morphological evidence of the presence in tumor cells of virus particles, which undoubtedly are the causative agent, as will be shown later, it may be concluded that the virus is both the initiating and the continuing cause of malignancy. This may perhaps serve as an example of the usefulness of electron-microscope studies of cancer, especially in combination with appropriate biological investigations.

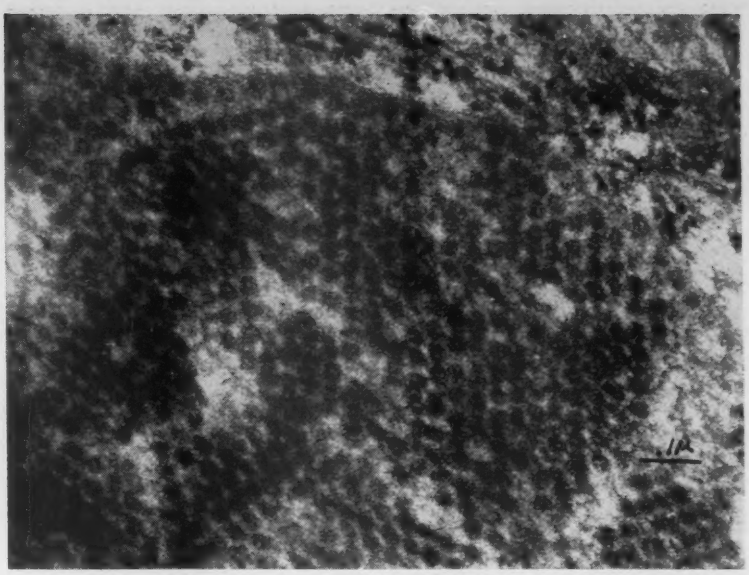
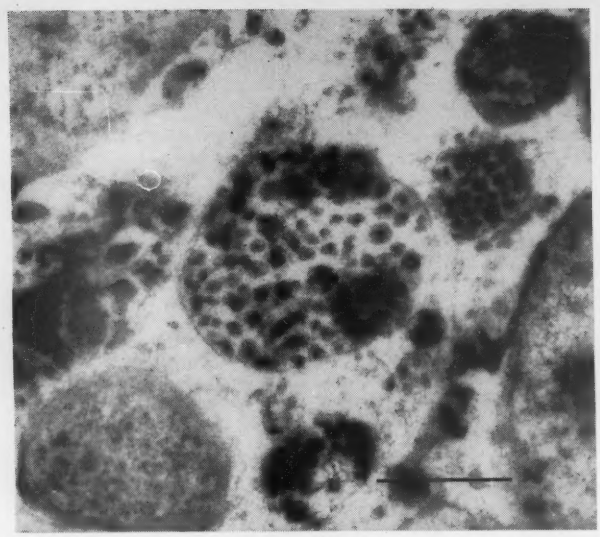


Fig. 5. Part of an inclusion body within the cytoplasm of a cell from a kidney tumor induced in a hamster by the polyoma virus. Virus particles may be seen in an orderly array (× 105,000). [L. Dmochowski, C. E. Grey, E. Bereczky, J. Blicharski]

A striking example of the continuous presence of the virus in tumors which it produces is shown by the adenocarcinoma of the kidneys of chickens. Burmester and his associates (*50*) have recently shown that cell-free preparation of material containing myeloblastosis virus induce in chickens not only myeloblastosis but also other types of chicken leukosis, such as visceral lymphomatosis, osteopetrosis, and cancer (adenocarcinoma) of the kidneys. A study of the submicroscopic morphology of the adenocarcinoma of the kidneys in chickens, both virus-induced and after repeated transplantations, has revealed similar changes in the cells of both types of tumors. Virus particles similar in appearance to those seen in the affected organs of chickens with myeloblastosis have been observed (*47*) (Figs. 6–9). Cell-free preparations of the transplanted adenocarcinoma induced in other chickens mostly the same type of cancer (*50*). Thus, again, electron microscopy appears to indicate the possibility of a virus being the initiating and continuing cause of yet another type of cancer—that is, of a tumor of chickens.

In view of the difficulties encountered in electron-microscope studies of animal tumors of known viral origin, it is not surprising to find as yet comparatively few studies of human cancer. Nevertheless, the progress made in the electron-microscope studies of animal tumors presented a challenge for similar studies of human tumors. The rapidly accumulating knowledge of submicroscopic morphology of animal tumors and the progress in the discovery of the viral origin of various animal cancers were sufficiently compelling to cause investigators to undertake electron-microscope studies of human tumors which, from comparison with animal tumors of known viral etiology,



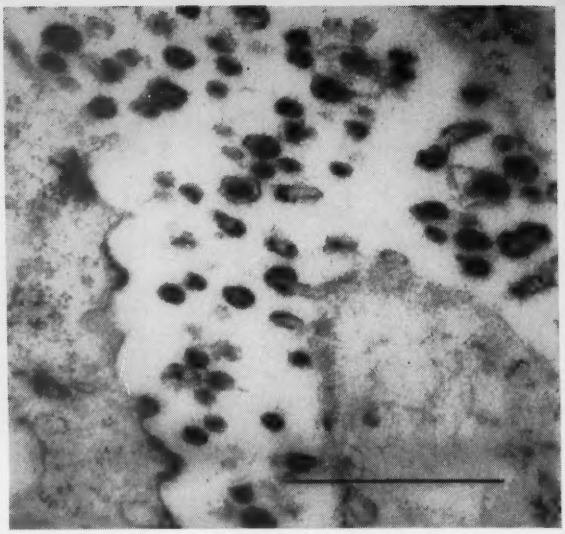


Fig. 6 (left). Part of the cytoplasm of a cell from a kidney tumor induced in a chicken by leukemia virus (myeloblastosis). Inclusion bodies with virus particles may be seen (about × 21,000). Fig. 7 (right). Kidney tumor induced in a chicken by leukemia (myeloblastosis) virus. Virus particles in the intercellular space and budding processes of cellular membranes may be seen (about × 36,000). [L. Dmochowski, C. E. Grey, B. R. Burmester, W. G. Walter]

were suspected of being also of viral origin. As far as is known, extensive studies of two types of human cancer have so far been carried out. These two types are leukemia in its various forms and breast cancer.

In an extensive study (*51*) of lymph nodes obtained by surgical procedures from patients with leukemia, changes were observed in the submicroscopic constituents of the cells surprisingly similar to those already found in the cells of leukemic organs from mice and chickens. As in murine and chicken leukemia, these changes alone could not be described as specific for cancer cells. In addition, however, virus particles were found both within and outside the cells of leukemic lymph nodes from human subjects (Figs. 10 and 11). There were no apparent differences in the size or internal structure of virus particles in the lymph nodes from human subjects with different types of leukemia. These particles were found in half of the cases examined but were not observed in cells from lymph nodes of patients apparently free of leukemia.

It is important that the difficulties encountered in the search for virus particles in human leukemic tissues be emphasized. Frequently, up to ten specimen blocks of tissue had to be cut in sequential sections before virus particles were found. (However, when they were observed in a certain block of tissue, they were present in considerable numbers in many sections of the block.) It is therefore hardly surprising that virus particles have not yet been observed in the circulating blood cells from leukemic patients (*32*) and that they have been observed in only one case of human leukemia in a surgical biopsy specimen (*52*). At this point it should be stressed that the observation of virus particles in human leukemic tissues and their absence in lymphoid tissues of patients apparently free of leukemia does not indicate in any way that these particles are the etiological agent of leukemia. Nevertheless, such studies constitute a preliminary and necessary step in the studies of viral etiology of human leukemia. These virus particles have also been observed in cells grown in tissue culture, derived from surgical biopsy specimens of leukemic patients (*51*). Such studies, combined with immunological and biochemical studies, may perhaps lead to characterization of the particles and may help in establishing the origin of leukemia in man.

Cells from 91 cases of human breast cancer studies in the electron microscope failed to reveal distinct virus particles (*53*). Virus particles have been observed in tumor cells in another study of human breast cancer recently reported (*54*). Since, as was mentioned above, there are no qualitative differences in the ultrastructure of normal and cancer cells, the observation of virus particles in a tumor is of great interest. Nevertheless, enthusiasm must be tempered with caution because of the realization that tumors may carry many viruses unrelated to their origin; they may also carry viruses capable of inducing tumors unrelated to the tumor in which they have been found and isolated. This has been amply demonstrated in the case of some animal cancers (*17*), such as leukemic tissues from which the polyoma virus was recovered.

The observation of virus particles in the cells of tumors raises the question of the relationship of these particles to various cell constituents and of the changes in these constituents which could conceivably be associated with the presence of virus particles. The scope of this discussion does not allow for a description of the submicroscopic structure of the various cell constituents, but there are excellent reviews on this subject available (*55*). The different cell constituents can also be isolated by physiochemical procedures, and their appearance can be studied by means of electron microscopy, which has contributed significantly to the study of the various cell fractions (*56*). Much remains to be done in electron microscopy of various cell fractions from tumors of viral origin, especially those which contain virus particles.

An observation of virus particles within different cell constituents can-

not in itself be interpreted as indicating the site of origin. It is often tempting to speculate about the mode of development of virus particles within various cell constituents because of their striking location. Pictures of the tumor cells taken by the electron microscope represent at best a series of stills. Tissue culture of cells infected with tumor viruses offers a better approach for study of the mode of development of tumor virus particles, especially in combination with electron microscopy.

Nucleolus and Nucleus

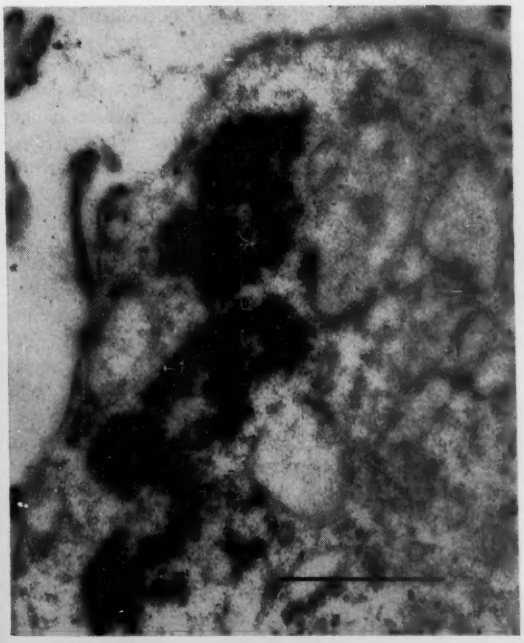
Enlargement of the nucleolus with condensation of some of its constituents has been observed in Rous sarcoma tumor of chickens (*57*) and in Shope papilloma tumor of rabbits (*58*). In the latter, virus particles have been observed in the network of the nucleolus (*58*). The nucleolus is frequently enlarged in cancer cells of the squamous cell carcinoma of the eye in cattle (*22*), in polyoma virus-induced tumors (*43*), and in human breast cancer (*53, 57*). Polyoma virus particles have occasionally been observed to be continuous with the denser filamentous material of the nucleolus (*59*). As in other virus infections, "dense bodies" have been observed scattered in the nucleolus and the nucleoplasm of the adenocarcinoma of the leopard frog (*60*), in Rous sarcoma of chickens (*61*), in polyoma-infected tissue-culture cells (*44*), in molluscum contagiosum, a benign human skin tumor (*28*), and in human breast cancer (*53, 57*). These aggregations within the nucleolus and nucleoplasm are strikingly similar to those noted in the cytoplasm of chicken adenocarcinoma of the kidney (*62*).

An intimate association of virus particles with threads of chromatin in the nucleus has been observed in rabbit papilloma cells (*58*), in polyoma-infected mouse embryo cells grown in vitro (*63*), and in polyoma-induced tumors of the kidneys in mice, rats, and hamsters (*49*). The distribution of chromatin, frequently considerably enlarged, along the nuclear membrane is a characteristic feature of cells infected with polyoma in vitro and in vivo (*49, 63*). As in other viral infections, inclusion bodies within the nucleus containing virus particles, frequently in regular "crystalline" arrays, have been found in polyoma virus-infected cells (*48, 49, 63*) and in polyoma-induced tumor cells (*49*). The virus particles have also been observed scattered at random in the nucleus of cells of Shope papilloma (*58*) and of polyoma-induced tumors (*43, 45, 49, 59*). A thickening and occasional duplication of nuclear membrane with polyoma virus particles between and outside the nuclear membranes have been occasionally observed (*63*) in polyoma-infected cells in vitro. All changes in the nucleus and nucleolus of virus-induced tumor cells are strikingly similar to those observed in cells infected with "ordinary" viruses (*22, 57*).

Cytoplasm

The changes observed in the different submicroscopic constituents of the cytoplasm are strikingly similar in virus-induced tumors in animals and in some human cancers in which virus particles have been observed or in which the particles could not be found (*22, 57*).

Mitochondria, one of the ultrastructural constitutents of the cytoplasm, may show only changes which can be described as degenerative, or they may show the presence of virus particles in what appear to be various stages of formation. Virus particles within mitochondria have been observed in visceral lymphomatosis, erythroblastosis, myeloblastosis, and renal adenocarcinoma of chickens (*22, 62, 64*) and in myeloblastosis cells in vivo and in vitro (*65*). They have also been found in regular arrays in mitochondria of polyoma-induced tumors of the salivary gland of mice (*59*) and of polyoma-induced tumors of the kidneys of mice, rats, and hamsters (*49*). In view of the known importance of mitochrondia in the biochemistry of cells, this "power plant" of tumor cells once again presents a



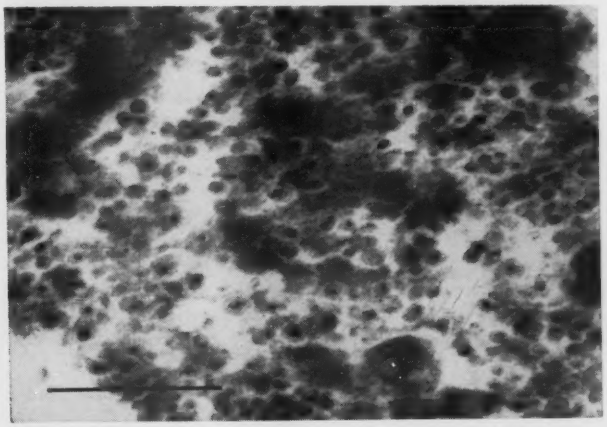
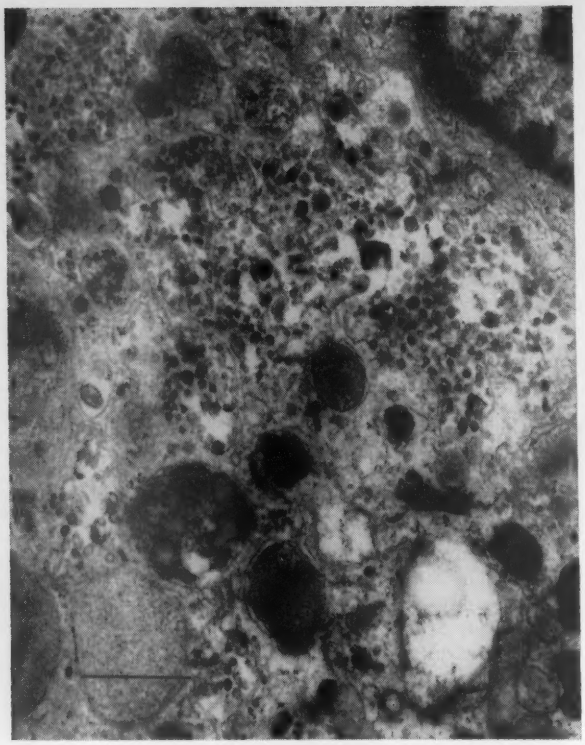


Fig. 8 (left). Part of the cytoplasm of a cell from a kidney tumor induced in a chicken by leukemia (myeloblastosis) virus. Characteristic aggregates, which precede the appearance of virus particles, may be seen in the cytoplasm (about × 26,000). Fig. 9 (above). Virus particles which appear within characteristic osmiophilic aggregates in the cytoplasm of some cells of chicken kidney tumor induced by leukemia (myeloblastosis) virus (about × 26,500). [L. Dmochowski, C. E. Grey, B. R. Burmester, W. G. Walter]



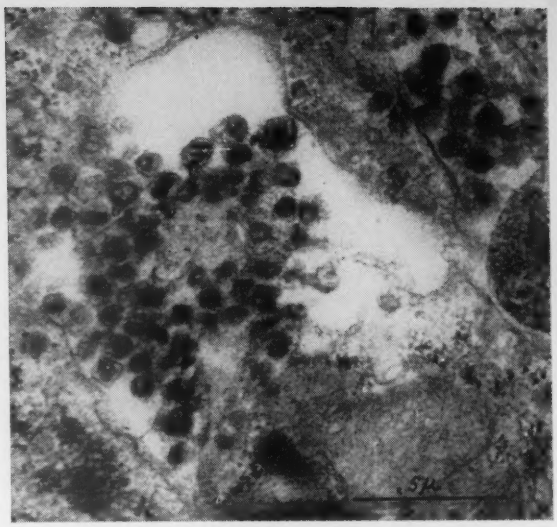


Fig. 10 (left). General appearance of a section of lymph node from a patient with acute lymphatic leukemia. Profound changes may be seen in the cytoplasm of cells, with inclusions and virus particles (about × 17,000). Fig. 11 (above). Virus particles in the intercellular space, in a section of lymph node from a patient with acute lymphatic leukemia (about × 50,000). [L. Dmochowski, C. E. Grey, J. A. Sykes, C. C. Shullenberger, C. D. Howe]

challenge to biochemists interested in oncology. The size of mitochondria may be increased to that of an inclusion body, as seen in the light microscope. Virus particles are occasionally found arranged in orderly arrays within the body, as seen in the electron microscope (*49, 59*). These morphological observations are indicative of profound changes in the biochemical economy of tumor cells, which appear at the same time to have their genetic apparatus affected by the intimate association of virus particles with chromatin in the nucleus.

An increase in the size of the Golgi apparatus in some virus-induced tumors has been encountered in breast cancer of mice (*23*), Rous sarcoma of chickens (*57*), bovine ocular squamous cell carcinoma cells grown in vitro (*66*), and human leukemic cells grown in tissue culture (*51*). However, no association with virus particles, except in breast cancer in mice (*23*), has been observed.

The ribonucleoprotein particles (*67*), another submicroscopic component of the cytoplasm, are known to increase in number in cancer cells. Characteristic aggregations of these particles have been observed in the cytoplasm of Rous sarcoma cells (*57*) and in chicken kidney adenocarcinoma cells (*62*), with virus particles present within these aggregates in cells of the kidney carcinoma of chickens (*62*).

Electron-microscope studies of normal and cancer cells have revealed an extensive system of membranes, interconnected and extending from nuclear membranes, through the membranes of endoplasmic reticulum or ergastoplasm, to the cell membrane (*22*). The latter appears to be intimately associated with virus particles in the cells of a number of virus-induced tumors, such as leukemia of mice (*68*), breast cancer of mice (*69*), erythroleukosis of chickens (*23*), and chicken renal adenocarcinoma (*62*). It is premature to speculate on the formation of virus particles from cell membranes, in view of observations of what appear to be progressive stages in virus development.

Tissue-Culture Studies

Susceptible cells grown in tissue culture and infected with tumor viruses have now been extensively studied in the electron microscope at different intervals of time after infection. The following tumor viruses have, so far, been studied in tissue culture: Rous sarcoma (*61, 70*), chicken myeloblastosis (*65*), Shope rabbit fibroma (*71*), and mouse breast cancer (*69, 72*) and polyoma (*43, 44, 63*). These studies gave a more detailed picture of changes which could be interpreted as the gradual development of particles of the various tumor viruses. Thus, combination of the method of tissue culture and electron microscopy gave support to the original observations on the ultrastructure of cells from virus-induced tumors, and to interpretation of the different ultrastructural forms as developmental stages of tumor virus particles. Bioassays of virus-infected cells in vitro, carried out at different intervals of time, lent further support to the conclusion that the particles are the various tumor viruses.

One of the important considerations in preparing tissue specimens for electron-microscope examination is the suitability of such specimens for phase and fluorescent microscope studies. In a study combining phase, fluorescent, and electron microscopy of cells grown in vitro and infected with polyoma virus (*63*), it has been possible to correlate morphological changes observed by these means with tumor-inducing activity of the tissue-culture material. The gross structure of these inclusions and their gradual formation could be ob-

served in the phase contrast microscope, their viral nature could be determined by observation of virus particles in the electron microscope, and their chemical composition could be assessed by pretreatment with nucleases, followed by staining with a fluorescent dye, acridine-orange. As there are as yet no staining procedures available which could differentiate viral from cellular ribonucleic or deoxyribonucleic acid, such integrated studies, in which fluorescent microscopy is combined with electron microscopy, are of extreme importance as they are helpful in indicating the type of nucleic acid carried by a virus.

Identification and Ultrastructure of Tumor Virus Particles

The increasing frequency with which characteristic particles have been encountered in the cells of various tumors of known and suspected viral origin has led to increasingly stringent criteria for the identification of certain characteristic structures, differing from normal ultrastructural components of cells, as virus particles and etiological agents of the disease under study. Again, electron microscopy, with its improved techniques of fixation and staining of specimens, combined with various biophysical and biochemical procedures, has greatly contributed to the morphological identification and biochemical characterization of different "ordinary" and tumor viruses (*22*).

An integrated electron-microscope and cytochemical study of chemically purified preparations of Rous sarcoma virus, combined with biological tests of such preparations, served as the means of identifying particles observed in Rous sarcoma tumor cells as Rous virus. This study showed, further, that the "nucleoid" or dense center of the virus particles is composed of ribonucleic acid (*73*).

Biophysical procedures, such as ultracentrifugation, combined with electron microscopy of biologically active pellets obtained by ultracentrifugation of plasma of chickens with myeloblastosis and erythroblastosis have provided evidence that particles present in such pellets are the causative agents of these forms of chicken leukosis (*74*). The ultrastructure of virus particles observed in ultracentrifugal pellets was found to be similar to that of particles seen in ultrathin sections of cells from these types of chicken leukosis.

Similar procedures have led to the identification of Shope papilloma virus particles and have clarified their ultrastructural appearance (*75*). Again, the structure of papilloma particles was found to be similar to the structure shown in sections of rabbit papilloma cells (*58*). These studies extended previously reported results on the size, shape, and density of papilloma particles (*76*).

Biophysical and biochemical procedures, combined with electron microscopy of ultracentrifugal pellets obtained from suitably treated milk of mice carrying the virus which induces breast cancer in mice (Bittner virus), have helped in identification of the characteristic particles as the Bittner virus (*38*). These particles are similar in size and appearance to those previously observed in breast cancer cells of mice (*35*, *36*). They do show greater details of ultrastructure (*77*), when an improved staining procedure is used (*78*). There appears to be agreement as to the size and appearance of Bittner virus particles, as similar results have also been obtained through the use of various biophysical procedures carried out on Bittner virus-carrying material obtained from different sources (*69*, *72*, *79*).

Thus, electron-microscope studies of tumor-inducing viruses have reached the second stage of their development, where it is now possible to devise experiments leading toward the identification of tumor virus particles. However, the requirements of quantitative electron microscopy (*21*) for identification of virus particles as causative agents of a disease can only be satisfied if a strict correlation is established between the number of characteristic particles and the titer of tumor-inducing activity of preparations containing the virus particles. Recently, new methods of staining for electron microscopy have become available which may meet the criteria of quantitative electron microscopy and, in addition, allow for a study of the ultrastructure of viruses on a molecular level (*24*).

As mentioned above, biological studies revealed a great similarity between "ordinary" viruses and tumor viruses. Electron-microscope studies of ultrathin sections of virus-infected cells and tumor cells induced by viruses revealed

Fig. 12. General appearance of a mouse embryo cell grown in tissue culture and treated with nucleic acid preparation from mouse lymphatic leukemia. The altered mitochondria and characteristic onion-like structures that precede the appearance of virus particles may be seen (× 16,000). [L. Dmochowski, C. E. Grey, L. O. Pearson, J. A. Sykes, R. G. Hughes]

that "ordinary" viruses and tumor viruses are similar in their relationship to the various submicroscopic constituents of cells. These studies have also shown a general similarity in size, shape, and structure of plant, insect, animal, and human viruses. As mentioned above, most virus particles are composed of a dense center (now known to be one of the nucleic acids) surrounded by a single, double, or multiple membrane. High-resolution electron microscopy of sections of tumor cells stained with heavy metals has already led to the visualization of an inner reticular or filamentous structure of the dense center, or the so-called "nucleoid," of some of the tumor viruses (*22*, *23*, *49*, *59*).

The recent application of staining technique with potassium phosphotungstate (*24*) to purified or even partly purified virus preparations has revealed previously unseen details of the structure of virus particles in the electron microscope. It is of extreme importance that such details agree with data on virus structure obtained by x-ray diffraction and other physiochemical methods. This method has demonstrated the structure of the protein shell, which is composed of subunits varying in number in different viruses. It has also been possible to observe the inner structure of the nucleoid, which is composed of a number of subunits arranged in the form of a flexible helical array in some of the animal viruses (*24*). Thus electron microscopy appears to indicate the existence within viruses of a structure which fulfills the essential property of viruses, the construction of the particle by the use of multiple, similar, protein subunits (*24*). This technique appears to retain the three-dimensional structure at the molecular level and at the same time preserves the activity of virus particles.

The application of this staining technique has shown the structure of the shell or coat of virus particles (*80*) already identified as the polyoma virus by other studies (*81*). It has also shown the structure of the coat of Shope papilloma virus particles (*82*). These in general are similar to structures observed in the coat of other viruses. The presence of particles with a hollow center has also been observed. These may be noninfectious particles or stages in the development of the infective particles. Such particles have been described in sections of virus-induced tumor cells (*22*, *23*).

Viral Nucleic Acid and Cancer

It is now known that viral nucleic acids from plant, animal, and human viruses transmit viral infectivity and induce changes characteristic of the particular virus (*7*). The nucleic acid is therefore the basis of viral activity. Nucleic acid from a virus can also lead to virus production in cells from nonsusceptible hosts without signs of disease or morphological changes (*8*). Nucleic acid from tissues infected with polyoma virus has been found to behave in a manner similar to that of nucleic acid from other viruses. It will induce changes characteristic of the virus in susceptible cells grown in tissue culture (*83*, *84*) and will induce tumors in susceptible animals (*83*). As yet there are no morphological studies of the submicroscopic appearance of cells treated with nucleic acid from tissues infected with tumor viruses to which the cells are known not to be susceptible. Such studies may reveal the behavior of submicroscopic constituents of cells, and whether formation of virus particles takes place. Electron-microscope studies of susceptible cells treated with nucleic acid preparations from leukemic and polyoma virus-infected tissues have shown changes similar to those observed during polyoma infection and the presence of characteristic virus particles (*22*) (Fig. 12). These morphological observations are supported by the results of biological and serological tests. Thus, a morphological confirmation has been obtained of the formation of polyoma virus particles within susceptible cells treated with the nucleic acid preparations from tissues infected with this virus. Electron-microscope studies of cells treated in such a manner, carried out at various intervals, may permit observation of the gradual development of virus particles and indicate the involvement of the various ultrastructural components in the formation of the particles.

Electron microscopy has shown that deoxyribonucleic acid in purified preparations consists of macromolecules 20 angstroms in length (*85*), and that ribonucleic acid consists of two types of molecules differing in length (*86*). It may be too much to hope that electron microscopy may in the near future help to distinguish the ribonucleic and deoxyribonucleic acid of the host from the nucleic acid of a virus. Nevertheless, it has already shown details of structure which appear to be rapidly closing the gap between morphology and molecular biology.

The problems of molecular biology are now increasingly important; hence attempts are being made to detect viral antigens by means of electron dense antibody conjugants (*87*). This approach offers hope of visualizing sites of antigen-antibody interaction on the molecular level. It appears that specific identification of antigenically distinct viral particles can be made by electron microscopy. This offers considerable hope for future studies of human cancer and the characterization of virus particles encountered in the cells of some human cancers.

Recent progress in electron-microscope studies of virus-infected cells, of cells of tumors induced by viruses, and of viruses themselves has provided a common meeting ground for morphologists, virologists, chemists, and physicists. It has led, through mutual interest, to considerable progress in our knowledge of viruses and animal tumors. Although electron microscopy of human cancer is still in the pioneering stage and a virgin territory, the ground is bound to be cleared through the cooperation of specialists in the different disciplines of science (*88*).

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88. This study was aided by research grants from the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service, and from the American Cancer Society.

Tektites as Natural Earth Satellites

Observations indicate that orbiting tektites, on entering the atmosphere, fall in a few revolutions.

John A. O'Keefe

Barnes, Kopal, and Urey (*1*) criticized the theory of lunar origin of tektites as put forward by me in 1958 (*2*), in part on the ground that the distribution of tektites does not agree with this theory. Barnes and Urey argue, in particular, that if the tektites spiraled in slowly from the moon, as suggested, they would be completely distributed around the earth in a band of latitude.

In my paper I did not specify the manner in which tektites traverse the space between the earth and the moon. The argument of Barnes and Urey is incontestably correct, however, in showing that the tektites could not have crossed this space as a group of bodies. It is essential to suppose that the tektites of each strewn field crossed cislunar space as a single large body. It is also necessary, in view of the lack of small strewn fields, to suppose that there is a lower limit to the size of a body which can produce tektites efficiently.

In an attempt to account for the distribution, a study has been made of the great meteor procession of 9 February 1913, for which the name "Cyrillids" is proposed (after St. Cyril's day, 9 February). This shower cannot be named after a radiant, since it had none, nor after a comet. The precedent followed here is the naming of the Perseids the "tears of St. Lawrence," because they fall on St. Lawrence's day. It has been shown by Chant, Burns, Denning, Davidson, Pickering, Fisher, La Paz, Mebane, and me (*3*, *4*), despite objections by Hoffmeister (*5*) and Wylie (*6*), that these objects were almost certainly a group of small earth satellites moving in an orbit of low eccentricity. La Paz (*7*), Fenner (*8*), and I (*2*, *9*) have suggested that there is a connection between tektites and the Cyrillid shower.

It is therefore of interest to see whether these bodies came down all around a band of latitude, as suggested by the comments of Barnes and Urey.

Narrowness and Uniqueness of Cyrillid Orbit

All of the observations of the Cyrillids which have been obtained thus far (see Fig. 1) pertain to a single orbital revolution, in which the bodies passed over Toronto at about 9:05 P.M. EST. Since the bodies remained in the atmosphere over a distance of some 6000 miles, it follows that the orbit must have been nearly circular. The next revolution should therefore have occurred some 90 minutes, or less, later. In Fig. 2 is shown the result of displacing the trace originally drawn by Chant westward by 22.9 degrees, corresponding to an orbital period of 91.5 minutes.

To discover whether the bodies passed over this line, use has been made of the fact, discovered by Mebane (*4*), that local newspapers of the date frequently carried stories about the Cyrillids. Along the Chant trace, Mebane uncovered about two dozen stories of this kind by correspondence with editors of the local newspapers. He very kindly lent me his whole correspondence, including both positive and negative replies, and the results are plotted in Fig. 2, together with the Chant trace. As may be seen, a substantial fraction of the newspapers replying from these areas carried accounts of the shower.

Mebane's investigations, as can be seen from the figure, covered a strip some 200 kilometers wide, centered on the Chant trace. In Michigan and Minnesota, numerous accounts were found to have been published at a considerable distance from the trace, while in New York and Pennsylvania, accounts were found only in the immediate vicinity of the trace. The reason is clear: the New York and Pennsylvania areas were cloudy, and nearly all the accounts there refer only to the noises of the meteors. People in some of these localities never knew the cause of the noises; those in others had learned about the shower from the Buffalo papers before the local papers were published. The noises died out before the meteors reached New York City; the single New Jersey account (from Watchung, near Plainfield) is a visual report; here the shower was seen, apparently through a hole in the clouds.

I visited upstate New York and verified my ability to locate such stories by rediscovering several of Mebane's accounts; I even located several accounts which had been overlooked by editors who corresponded with Mebane.

Next, I visited the libraries of the state historical societies in Columbia, Mo., and Lincoln, Neb. I examined a total of 260 newspapers in these two places, with entirely negative results. Individuals recommended by the state historical societies in Nebraska, Iowa, and South Dakota were engaged to do further work, but all of their results were negative. In addition, Jesse Jameson of the State Historical Society, Wyoming, undertook to search the Wyoming files himself.

As shown in Fig. 2, all of these searches along the hypothetical path of the second revolution of the Cyrillids gave negative results, although in my opinion they were just as thorough as those along the Chant trace, and they involved many more newspapers. In a few cases, the search turned up a wire-service report from Buffalo referring to the passage over that city. These cases gave reassurance about the alertness of the searchers.

In a further effort to locate the second pass, a special request was made to the Weather Bureau Records Office, at Asheville, N.C., for a search of their records. The results of the search are shown in Fig. 3; the Weather Bureau had already made all of the positive

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Fig. 1. Observations of the Cyrillids to date.

Fig. 2. Observations of the Cyrillids reported in local newspapers in the United States.

Fig. 3. Weather Bureau observations of the Cyrillids.

results available, either to Pickering (the ship observations) or to Mebane (the land observations), except for a precise and valuable account from Duluth. The Weather Bureau search covered the Pacific and the whole North Atlantic. It is clear from the results that the Cyrillids were visible only along the Chant trace.

As a final effort, an examination was made of some 200 metropolitan daily newspapers, filed at the Library of Congress, for the week of 9 February 1913 (see Fig. 4). Four accounts were located, three in Michigan papers and one in a Buffalo paper. Alertness in searching was indicated by the discovery in about 16 papers of reprints of the original reports carried by the wire services. In addition, accounts were found in New York and Philadelphia papers, for Saturday, 15 February, coming from ship observations allegedly made on 10 or 11 February. The latter were apparently misdated; the locations, however, were on or near the Chant trace at sea, so far as could be determined from crude accounts. The logs of these ships cannot be located. Whether or not the ship accounts are included, this homogeneous survey indicates once more that accounts of the Cyrillids cannot be found except along the original Chant trace. It demonstrates that the night of 9 February 1913 was not a night of general meteoric activity, as suggested by Hoffmeister and Wylie.

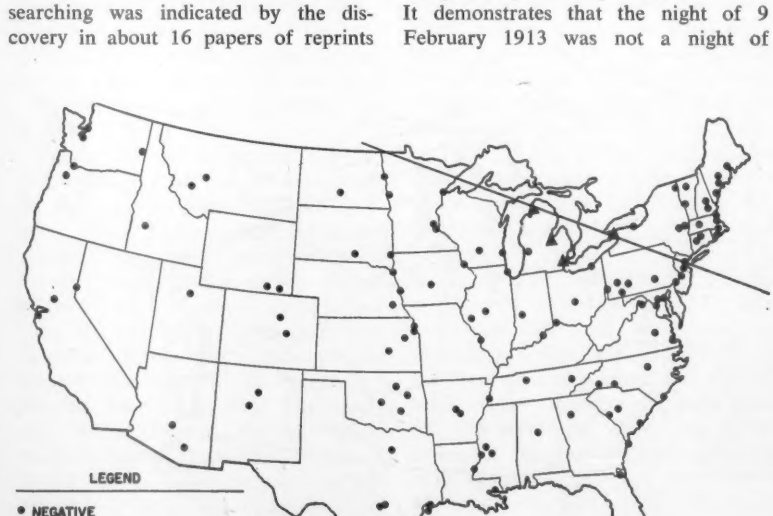

Fig. 4. Results of a survey of U.S. metropolitan newspapers in Library of Congress files (chiefly daily papers), made to locate accounts of the Cyrillid shower.

These observations exclude the possibility that a large display was made on the revolution following the one studied by Chant and the others (*3, 4*). They do not necessarily exclude the possibility of a minor display on the previous revolution. The display would presumably have occurred near the perigee point. From the manifestations which are available, it appears that the perigee point lay somewhere between the latitudes of Toronto and the Equator. The corresponding part of the previous revolution fell along a line from Labrador over the eastern Atlantic, in a region not much favored by British or American shipping.

From these observations we can conclude that there exists a mechanism by which bodies entering the atmosphere from a satellite orbit may fall in one or a few revolutions, without covering a complete band of latitude. Possible mechanisms are discussed below, but it is important to see that the existence of some such mechanism is a matter of observation, regardless of whether or not it can be explained.

Eccentricity of Orbits of Cyrillids and Tektites

It appears clear at once that the sharp cutoff of the Cyrillids implies that they had not been in orbit for a long time as separate bodies. If they had been, then the differences in drag between them would have caused a considerable number to survive into the next revolution. They probably became separated from the parent body at perigee on the revolution prior to the one on which they were observed.

In this case, the parent body must have had a measurable eccentricity. This follows from the fact that the daughter bodies would be expected to return to the same perigee height at which they were separated, and, at the same time, all daughter bodies would have shorter periods than the main body. If the main body had been in a very nearly circular orbit with a low perigee, any daughter body would fall to the earth at once. On the other hand, if the main body had a small eccentricity, say 0.02, then the daughter bodies could have a range in eccentricity from this value to zero, as shown in Fig. 5. With this choice of eccentricity, the range in period is about 3.3 minutes, a figure in agreement with the

statements of witnesses that the shower took about this long to pass a given point. Larger eccentricities are possible, but difficult to reconcile with the great length of the path and with the statements of witnesses everywhere that the path was nearly level.

The hypothesis of nonzero eccentricity for tektite orbits is also helpful in understanding the breadth of some of the strewn fields, such as the australite strewn field. Fenner (*8*) mentioned that if the australites had been derived from an event such as the Cyrillid shower, they would have had "a distribution much narrower than the observed" 2500 kilometers minimum width. If, however, the australites arrived in an orbit whose eccentricity was 0.5 or more, then the distribution can be understood. Suppose that the outermost ellipse in Fig. 5 represents the orbit of the main body on its last revolution. Inner ellipses represent the orbits of drops sprayed from the main body during its pass through the atmosphere on the previous revolution. These will all return at approximately the same perigee height, but the smaller bodies will precede the main body to perigee by amounts up to P—90 minutes, P being taken as the period of the main body and 90 minutes, as an approximation to the minimum value for the period of one of the smaller bodies. During the period P—90 minutes, the rotation of the earth will widen the strewn field by $(P—90)/4$ degrees of longitude. Since the actual breadth of the Australian continent is some 60°, it is clear that no very improbable values of P are demanded. Of course there would also be a spread along the orbit resulting from the range in drag coefficients among the droplets. The two ranges combined would yield the broad yet sharply cut off distribution which has been such a puzzle.

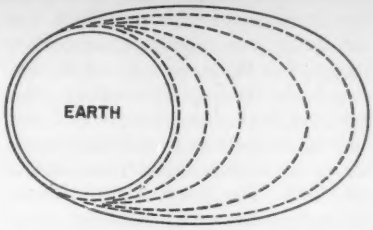

Fig. 5. Orbits of the Cyrillids. Solid lines, orbits of main body; dashed lines, orbits of daughter bodies.

History of Parent Bodies

A measurable eccentricity (and, even more, a large eccentricity) on the last revolution implies that the perigee of the orbit was low in the atmosphere—perhaps under 100 kilometers—throughout the history of orbital decay. This is a serious difficulty since only a small fraction of the particles ejected from the moon could possibly have initial perigee heights as low as 100 kilometers. A probable explanation is that the orbit was initially different, and that it was subjected to strong lunar perturbations, as would be the case with any body coming from the moon. The perturbations would continue for a considerable time, since the effect of a close encounter would be to change all parts of the orbit except the point of the encounter. Eventually, the body would either leave the earth-moon system, or strike the earth, or strike a low layer of the atmosphere. In the latter case, the effect of atmospheric drag would be to remove the apogee from the vicinity of the moon's orbit after only a few revolutions, and thereafter the evolution would be controlled by drag.

According to remarks made by A. H. Hibbs at the Goddard conference on meteorites and the moon, such perturbations manifest themselves strongly in the case of calculations made for lunar probes. Hibbs remarked that his calculations indicated that atmospheric capture is rare as compared to direct collision with the earth.

We must, therefore, as a corollary to the eccentricity of tektite orbits, accept the probable conclusion that most of the lunar material which reaches the earth does so not as tektites but in some other, not yet recognized, form. It is possible to understand how lunar material might escape attention even if it were of the same chemical composition as the tektites and more abundant. The composition of tektites is not sufficiently different from that of terrestrial material to attract attention. Tektites (Fig. 6) attract the attention of local collectors because they are glass and, especially in the case of the australites, because of their shapes and markings. Without these peculiarities, which are the result of arrival along a grazing path, it is likely that they would get by unnoticed unless an actual fall were observed. Even in that case their acidic composition would give the meteoriticists pause; the latter have to reject about a thousand objects for every real meteorite brought in, and they rely heavily on chemical composition as a guide.

It is also necessary to understand why there are so few small strewn fields, or none at all. If we remember that the energy available for the ablation of a body is its kinetic energy, which is pro-

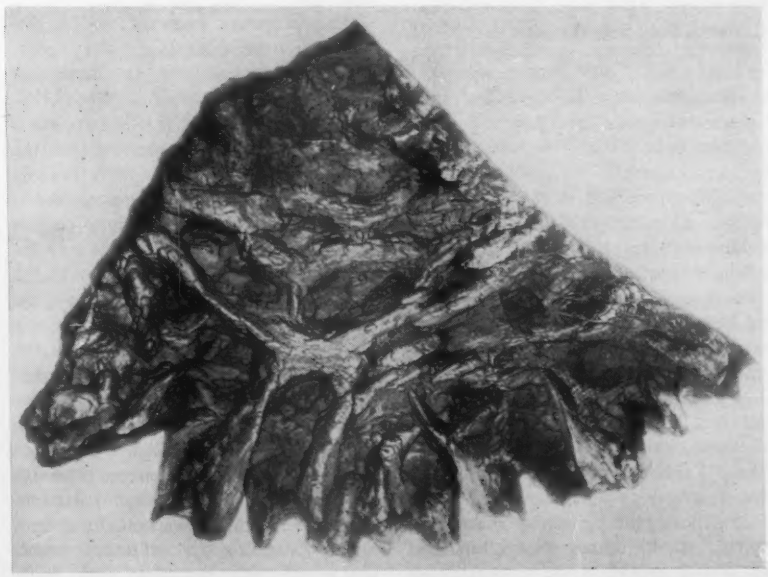

Fig. 6. Tektite weighing 17.8 grams, probably a fragment of a larger individual, found in 1959 at Gay Head, Martha's Vineyard, Mass., by J. N. Chase and C. A. Kaye. This specimen has been studied by the Smithsonian Institution, the U.S. Geological Survey, and the Massachusetts Institute of Technology (about × 2.1). [Smithsonian Institution]

portional to its mass, while the radiation from a body is proportional to its area, we see that, in principle, it should be possible for sufficiently small bodies to reach the earth after suffering relatively little melting. This line of reasoning is ordinarily applied to the micrometeorites, but it is clear that along grazing trajectories, where the heating is so much more gentle than in a typical meteor trajectory, the same reasoning may apply to very much larger objects. It is perhaps in this way that smaller chunks of lunar material manage to reach the earth's surface without being transformed into droplets.

In conclusion, therefore, it is found that the theory of a lunar origin for tektites can be reconciled with the criticisms of Urey and Barnes with respect to the distribution, but that to reconcile them requires us to assume, first, that the orbits are measurably eccentric; second, that the glassy form of the tektites is the result of atmospheric ablation; and third, that lunar material also reaches the earth in considerable quantity in some other, probably inconspicuous, form. The conclusion of Kopal, that some source nearer than the moon is required to account for the narrow distribution of the tektites, is valid in the sense that the breakup into separate bodies takes place in the earth's atmosphere (*10*).

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10. I wish to thank Kenneth B. Holmes of the Missouri State Historical Society, Donald F. Danker of the Nebraska State Historical Society, Edythe L. George of the South Dakota State Historical Society, Roy L. Fox, director of the National Weather Records Center, Asheville, N.C., and especially Alexander D. Mebane of New York City for kindness in supplying the information on which this article is based.

Science in the News

Kennedy's Program for Education: Teachers' Salaries; Construction; Scholarships

This week the President submitted to Congress what he described as a "modest program" for education. For the first year (fiscal 1962) it calls for spending about $700 million beyond the billion proposed in the Eisenhower budget, with built-in increases of $400 million each year for fiscal '63 and '64.

The program includes the two principal innovations Kennedy had committed himself to support: aid for teachers' salaries and a federal scholarship program. The amounts of money involved, though, are smaller than those in the bill that passed the Senate last year, and smaller still than those recommended by Kennedy's task force on education.

In general, the pattern of the education message follows that established by earlier proposals on medical care and minimum wages, to which Kennedy also attached the term "modest": he has compromised on dollar figures while holding out for innovations in principle.

The minimum wage bill, to the dissatisfaction of organized labor, abandons the request for an immediate raise from $1 an hour to $1.25, settling for an increase by steps over a period of 3 years; the medical care bill provides smaller benefits than those in the bill Kennedy and Senator Anderson sponsored during the rump session of Congress; the education bill asks for only about half as much money in the first years as the $1.5 billion a year measure that Kennedy's task force recommended. In each case, though, the really controversial point is less the dollar figures than a new legislative principle: in the case of minimum wage, an expansion of the definition of the Constitution's interstate commerce clause to cover not only businesses involved in interstate commerce but businesses merely "affecting" interstate commerce; this would cover just about every business of any consequence in the country. In the case of medical care, the new principle, of course, is the inclusion of health services under the social security system.

In the case of education, the point of controversy is money for teachers' salaries, with its clear implication, conceded by the Administration, that this involves a permanent commitment of the federal government (as opposed to a bill limited to school construction, which might be regarded as an emergency program to be terminated when the classroom shortage had been met).

In each case Kennedy is asking for expansion not merely of the amount of federal spending, but of the area in which the federal government will operate. Like the other major proposals, the education measure will face heavy conservative opposition both on the grounds that the expanded federal authority is unwise in itself and because once the new principle is accepted expansion of the program becomes virtually inevitable, even if the proposals for the first year or two are comparatively modest. The education program will almost surely pass the Senate without difficulty; indeed the Senate, as it did last year, will probably vote for a larger program than the President has asked for. But it will be quite a triumph for the Administration if it can get a bill granting money for teachers' salaries through the House.

Sam Rayburn, Speaker of the House, greeted Kennedy's message by announcing that he was still opposed to grants for teachers' salaries, and considering the close division in the House between liberals and conservatives that showed up in the vote on the Rules Committee, it is hard to see where

Kennedy will get the votes to support any measure that Rayburn will not support. Rayburn is supporting the grants for school construction, and this much of the program (about $300 million a year) will presumably go through. If so, the final form of the education bill will depend on what sort of compromise is worked out between the bill including teachers' salaries that seems certain to pass the Senate and the bill limited to construction that will probably come out of the House.

Federal Scholarships

Kennedy's message also included a less controversial proposal for a federal scholarship program averaging $700 for 25,000 students the first year, to grow to 50,000 in the third year. If the proposal passes this year in the form Kennedy has requested, the first scholarships will be awarded to students entering college in September 1962. Since each scholarship will run for 4 years, the program, even if it is not expanded, will involve 200,000 students by the mid-1960's. Following the principle described here last week for the medical scholarships proposed in the health message, each scholarship would be accompanied by a grant to the school the student attends. Its purpose would be to help cover the expenses the school incurs in accepting the student beyond the tuition he is charged. This grant would be $350 per year per scholar. All told, then, the federal scholarship program will be costing the government over $200 million a year by 1968. This, of course, would be in addition to the loan and graduate fellowship programs already existing, which Kennedy says will have to be expanded.

The rest of the message proposed two programs of low-interest loans to encourage university expansion: $250 million a year to continue the college dormitory program, a $50-million increase over Eisenhower's recommendation, and $300 million a year for a new program to provide similar loans for college classrooms, libraries, and laboratories. Eisenhower had cited the inclusion of such a proposal as one of his reasons for vetoing a housing bill 2 years ago.

The education program, then, goes well beyond Eisenhower's recommendations and of course much further beyond what the conservative coalition in the House will willingly accept. It involves a fair amount of money for fiscal 1962, and a built-in commitment to spend much more, in the years that follow. Yet Kennedy's description of it as "modest" is not far-fetched. For in no important way does it go beyond what Nixon recommended in his campaign policy paper on education (*Science*, 30 September), or beyond what the President's Commission on National Goals recommended to Eisenhower in December (*Science*, 2 December). The grants for public schools would add only about 7 percent to the $12 billion a year that is already being spent by non-federal sources.

There is virtually no argument over the need for more money for education. Eisenhower's final economic message described the need for "a huge expansion of the nation's commitment to education." But Eisenhower hoped the problem could be solved without a massive commitment by the federal government. Kennedy, and, more reluctantly, Nixon and the National Goals Commission saw no other way to meet the problem.

Two major reasons have forced this conclusion: one is that, as with scientific research, many aspects of education are national rather than state or local problems. It is not any particular state, the liberals argue, but the nation, that is faced with a shortage, for example, of scientists. This means that the national interest demands a heavier commitment to education than the sum of the interests of the 50 states. Even if the states were ideally responsive to their individual needs there would still remain a gap to be filled by the federal government.

But the state legislatures, in almost every case, are dominated by a rural minority of the state's population, while the problems that lead to the need for more investment in education are most acute in the cities. "The more the role of the states is emphasized . . .," said Eisenhower's Commission on Intergovernment Relations, "the more important it is that the state legislatures be reasonably representative of all the people." "One result of state neglect of the reapportionment problem," the same report said, "is that urban governments have bypassed the states and made direct cooperative arrangements with the national government." With education, as with slum clearance, water pollution, and any number of other problems, the argument is made that it is not a question whether the states or the federal government should do the job, but of the federal government or no one.

The principal item left out of the message was a program of direct building grants, rather than loans, to private and public universities. Two explanations were offered by Administration spokesmen: the limitation in the amount of money the President felt he could ask for this year, considering the other requests he has made or will make for more money in other areas, and the constitutional question that might be raised about grants to colleges that are connected with a church.

The loan program Kennedy proposes saves the colleges some money on financing bond issues, but nearly all the money must be paid back to the federal government over a period of years. To the extent that the universities face long-range financial problems, the federal loan program only delays the time when their problems become critical.

It is widely assumed that sooner or later grants as well as loans will be necessary. Nixon proposed a grant program in his policy paper on education, and the educational associations in Washington were disappointed that Kennedy's message did not include building grants. The message did take a small step in that direction in the proposal that a $350 grant to the college accompany every federal scholarship.

Administration officials have continued to try to keep the civil rights aspects of education programs quiet. They have promised not to withhold funds from segregated school systems unless Congress requests this, which is impossible since any bill with an anti-segregation ammendment would be filibustered in the Senate if there were any chance that it might otherwise pass. Nevertheless, as noted here last week, there will be a good deal heard about segregation when the bill comes to the floor.

Civil Rights

The proposed legislation does provide safeguards at two points to keep the money from being used to strengthen discrimination: the money in the public school grants will be based on the number of students attending public schools, and it can be used only for public schools. This means that a district which tries to set up a system of private schools to avoid integration will get no federal assistance, and a state may even find it awkward to divert part of its funds to help the private school system, for to do so may cause it to fall below the minimum state effort for public schools required by the bill before a state is eligible for aid.

There is also a safeguard in the scholarship program, which will be administered through the states in order to minimize charges of federal domination of education. But the bill provides that there must be no discrimination and gives the federal government the power to hold up the money if the state's method of awarding scholarships is ruled discriminatory.

Rival Bills

Along with Kennedy's proposals, Congress has before it a panorama of rival school bills, representing the whole range of the political spectrum. Briefly summarized, and from left to right, here is a classification of the major ones:

The National Education Association bill: permanent subsidy for public education starting at about $1.4 billion the first year, climbing to $5 billion in the fourth year.

The Administration bill: $666 million the first year, $766 the second, $866 the third. States required to spend 90 percent on construction and teachers' salaries; 10 percent is available for "special problems."

Liberal Republican bill: In the same price range as the Administration bill, but with more money for the poorer states, and with the states free to spend the money in any legal way: that is, encouraged but not required to use a large share of it for teachers' salaries. Based, incidentally, on a bill introduced by Senator Taft, with bipartisan support, in 1947. Much the sort of bill that Nixon promised during the campaign.

Eisenhower Bills (bills the former President indicated were acceptable to him last year): either a long-term federally financed bond issue or grants, limited to a temporary program of school construction. If grants, it would cost about $300 million for several years; if bonds, about $60 million for 20 years.

Goldwater Republican bill: Unspecified as yet, but will involve allowing taxpayers deductions from their federal taxes to make more money available for state school taxes. Goldwater wing feels it has gotten a bad reputation as mere obstructionists. Therefore they have promised to offer alternatives, such as this one on education, to all liberal proposals involving greater federal spending or expansion of federal powers.

In general, most Democrats and the liberal Republicans are fairly close, both willing to provide money for teachers' salaries: the predominant view in the Senate. The Eisenhower view predominates in the House, but with strong Goldwater sentiment among most Republicans and Southern Democrats. The Goldwater bill is given no chance of passage, and its supporters will oppose anything else.—H.M.

News Notes

Lysenko Regaining Power in Soviet Biology

Recent events indicate that Soviet biologist Trofim D. Lysenko, who had great political and scientific power under Stalin, is regaining the influence that he began to lose with Stalin's death. Lysenko first won favor by maintaining that he could change plant heredity through environment, a theory that is rejected completely by Western geneticists. Soviet scientists who opposed Lysenko's views were discredited and in many cases lost their positions.

The most distinguished of these victims was geneticist Nikolai I. Vavilov, who died in a Siberian concentration camp during World War II. One of the evidences of Lysenko's diminished stature was the posthumous publication of Vavilov's works by the Soviet Academy of Sciences in 1956.

Last November this section published an erroneous report that Lysenko's influence was still waning, a report that was based on apparently current material from the Office of Technical Services of the U.S. Department of Commerce. One of the protest letters received as a consequence comments: "It is very unfortunate that a governmental report should be so erroneous, in regard to so important a matter." Another letter observed: ". . . You have inadvertently misled your readers, who, like me, were optimistic enough to believe that the report of the Office of Technical Services was an up-to-date revelation of a change of wind in Russian science."

Olshansky's Appointment Significant

That Lysenko is regaining influence was clearly demonstrated recently when Mikhail A. Olshansky was named minister of agriculture. Olshansky has been a devoted supporter of Lysenko's for many years and was the opening speaker at the 1948 session of the Lenin Academy of Agricultural Sciences at which Lysenko delivered an attack on academic scientists who opposed his views and quoted the Communist party's Central Committee in a way that established his ascendency beyond question.

Last month a New York *Times* article pointed out that the recent Soviet debate on agricultural policies, culminating in a sweeping reorganization of agricultural administration and Olshansky's appointment, indicated that Lysenko has won a key role in Premier Khrushchev's hierarchy "and is again bidding to set up his own political-scientific 'empire.'" Lysenko's rise is reported to have accompanied an intensive behind-the-scenes political struggle, the focus of which has been the continuing failure of Soviet agriculture to meet the optimistic levels of production promised by Khrushchev.

Lysenko's most recent project has been to increase Soviet butterfat production through widespread use of a special stock of bulls that he has bred. Farm leaders who opposed this plan have been ousted, including Olshansky's predecessor, Vladimir V. Matskevich.

1961 Federal Research Support Estimated at $9.1 Billion

The federal government will obligate an estimated $9.1 billion during fiscal year 1961 for the support of scientific research and development, according to the National Science Foundation. The estimate includes $8.5 billion for conduct of research and development and $600 million for increase of the research and development plant. About $850 million of the $8.5 billion—10 percent—is marked for basic research.

The 1961 total of $9.1 billion compares with obligations of $7.4 billion in fiscal year 1959 and an estimated $8.6 billion for fiscal year 1960, according to *Federal Funds for Science, IX: The Federal Research and Development Budget, Fiscal Years 1959, 1960, and 1961*, which NSF has just issued. The publication presents detailed information on obligations for the conduct of research and development in terms of administering agencies, performers of research and development, and character of the work.

Summary data for fiscal year 1961 reflect congressional action on the President's budget and subsequent administrative decisions. This is the first time such data have been introduced in this

series. Also presented for the first time are data on federal support of research and development abroad. Likewise, more detailed information, by field of science, on total research and basic research has been added.

In fiscal year 1961, three agencies—the Department of Defense, the Atomic Energy Commission, and the National Aeronautics and Space Administration—are expected to administer an estimated 90 percent, or $7.6 billion, of the total obligations for conduct of research and development. In fiscal year 1960 these agencies accounted for the same percentage of the total.

In fiscal year 1960, the year during which the estimates were submitted, funds administered for basic research ($747 million) represented more than 9 percent of the federal government's support of research and development. Forty-four percent of total federal obligations for basic research were allocated to educational institutions; 30 percent to federal agencies; 14 percent to profit organizations; and 12 percent to other organizations.

It is estimated that about one-fourth of total obligations for the conduct of research and development, or $1.9 billion, was committed for basic and applied research in fiscal year 1960. Of this amount, the physical sciences, including mathematical and engineering sciences, accounted for 56 percent and the life sciences for 27 percent; the remaining 17 percent was distributed among the psychological, social, and other sciences.

Copies of *Federal Funds for Science, IX* may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (50 cents a copy).

London Has Society for Visiting Scientists

In London the Society for Visiting Scientists, which came into existence during World War II, offers a center at which foreign and overseas scientists visiting the United Kingdom may meet informally with other visitors and with British scientists.

The society provides club and restaurant facilities, and there are overnight accommodations for a limited number of visitors. There is a small library. Contact is maintained with a large number of scientists abroad and, through an information service and in other ways, the society is able to assist the activities of scientists on short visits to England, as well as, occasionally, those of British scientists traveling abroad. Students from overseas studying in England are brought together in the activities of the Overseas Science Students Association for which the society provides a home.

The work of the society, of which A. V. Hill is president, is made possible by the subscriptions of its British members, a grant from the British Council, and donations from industrial and other bodies interested in fostering closer understanding among scientists of all countries.

The society maintains an information service and is able to furnish details on the activities, scientific interests, and whereabouts of some 70,000 scientists. Increasing use is being made of this service by individuals and organizations who wish to get in touch with scientists working in specific fields. Inquiries are welcome.

Further information about the society may be obtained from the assistant secretary, Miss E. Simpson, at the organization's headquarters.

News Briefs

Communications satellites. Recent action by the Federal Communications Commission permits the American Telephone and Telegraph Company to launch a series of experimental communications satellites capable of relaying telephone calls, television programs, and other messages across the Atlantic. The company, with government assistance, plans to launch its first satellite within a year, as a forerunner of a global satellite system.

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South Pole expedition. An eight-man scientific traverse party arrived at the South Pole in the middle of February after a 65-day trek through many antarctic regions never before explored. The leader of the group, Albert P. Crary, chief scientist of the National Science Foundation's U.S. Antarctic Research Program, now joins the select group of two or three men who have been to both the North and South Poles. He was at the North Pole in 1952, doing scientific work on ice island T-1.

The current traverse of more than 1200 miles originated at McMurdo Sound on 10 December. The scientists made measurements to determine the elevation and thickness of the ice cap and the nature of the subglacial rock surface. Ice in some areas is about 2 miles deep, and analysis of ice cores is expected to provide valuable information on the past history of the ice and on past climatic conditions in Antarctica. The traverse was conducted by the University of Wisconsin under a National Science Foundation grant.

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Asian research headquarters. A new office to administer agricultural research grants in the Far East has been opened in New Delhi, India, by the U.S. Department of Agriculture. Named the Far Eastern Regional Research Office, it is directed by Paul W. Oman, formerly head of the insect identification and parasite introduction research branch of the USDA's Agricultural Research Service. The Delhi office will administer USDA grants for research to be conducted by institutions in India, Japan, Pakistan, Ceylon, Indonesia, Burma, and the Philippine Islands.

The USDA foreign research program is paid for with foreign currencies accruing to the account of the United States from sale of surplus agricultural commodities abroad under Public Law 480. About $3.5 million is available for research in the Far East in fiscal 1961.

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Salter memorial. On 10 February, the late William T. Salter, professor and chairman of the department of pharmacology, Yale University School of Medicine, from 1941 to 1952, was honored by former students, faculty associates, and friends for his many contributions to pharmacology, medicine, and graduate education. A portrait of Salter by Furman J. Finck was presented to Dean Vernon W. Lippard in the Beaumont Room, Sterling Hall of Medicine, by the W. T. Salter Society. Jerome M. Glassman, president of the society, unveiled the painting and gave the dedication address.

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NATO institutes. Under the sponsorship of the North Atlantic Treaty Organization, some 24 advanced-study institutes will be held in NATO countries during 1961. These institutes, covering advanced specialized fields, vary in length from 1 week to about 2 months, and most of them are scheduled for the summer holiday period. The National Science Foundation has announced that a limited number of transatlantic travel grants, providing only transportation costs, will be avail-

able to U.S. citizens who have been accepted by the institute directors. Further information on these institutes should be obtained directly from the pertinent institute directors, a list of whom may be obtained from the National Science Foundation, Washington 25, D.C.

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M.I.T. centennial. Some 100 world leaders in the arts and sciences will meet at the Massachusetts Institute of Technology during a week's centennial celebration next April. They will participate in an International Conference on Problems of Scientific and Engineering Education, 3–6 April, that will be the highlight of a varied program of events. John E. Burchard, dean of the School of Humanities and Social Sciences, is chairman of the Centennial Celebration Committee.

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New rocket research company. Three former Boeing Airplane Company engineers have formed the Rocket Research Corporation to conduct research, development, and manufacturing in Seattle. President is George S. Sutherland, former head of Boeing's Advanced Propulsion Group. He previously conducted research on solid propellants at Princeton University's Forrestal Research Center. Board chairman is Robert M. Bridgforth, formerly chief of the Boeing Propulsion Research Unit and a former member of the teaching and research staff of the Massachusetts Institute of Technology. Regis A. Hacherl, secretary-treasurer, headed Boeing's evaluation and experimental program in chemical rockets.

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Congress on medical librarians. The Medical Library Association has invited the second International Congress on Medical Librarianship to meet in Washington, D.C., 16–22 June 1963, at the time set for its own 62nd annual convention. Development of plans for the congress, to date, include the appointment of Frank B. Rogers as general chairman and M. Ruth MacDonald as executive secretary, and the establishment of an organization committee with special responsibilities for program development. The congress secretariat will be located in the National Library of Medicine.

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Quaternary research. A meeting of the International Association for Quaternary Research will be held in Poland during the late summer of 1961. The congress, which meets every 4 years, will be preceded by an excursion, which will set out from Warsaw on 27 August. Regular sessions will be held from 2 to 7 September, and a postcongress excursion is scheduled for 7–21 September. Although the congress has been attended primarily by Europeans, it is international, and non-Europeans are urged to attend. For information, write to Prof. Rajmund Galon, Secretary General, INQUA, Geographical Institute, University, Tourn, Poland.

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Communication Research Institute. The Communication Research Institute of St. Thomas, chartered by the government of the U.S. Virgin Islands as a nonprofit institution, has recently begun construction of a new laboratory building in St. Thomas and has opened a branch in Miami, Fla. The organization's research program is devoted to basic biological, biophysical, and psychological processes of communication. At present a major study of the bottlenose dolphin (*Tursiops truncatus*) is under way.

The institute is seeking personnel in the fields of biophysics, acoustic physics, linguistics, mathematics, solid-state electronics circuitry, neurophysiology and psychophysiology, neuroanatomy, physiology, and general marine animal care. For information write to John C. Lilly, Director, Communication Research Institute, 3908 Main Highway, Miami 33, Fla.

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Teratology Society. The Teratology Society, a new international organization devoted to study of the cause and prevention of congenital malformations, has been formed, with Josef Warkany, professor of research pediatrics, University of Cincinnati College of Medicine, as president. The first official meeting will be held in May in Cincinnati.

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Guide to reactors. The third volume of the *World Directory of Nuclear Reactors* has been published by the International Atomic Energy Agency. The new volume, a supplement to volume 2 of the *Directory*, which was published in December 1959, contains detailed information on 96 research, test, and experimental reactors currently in operation or under construction in 21 countries. The reactors have been grouped into the following main categories: light water moderated, pool type (27); light water moderated, tank type (21); liquid homogeneous (16); solid homogeneous (19); heavy water moderated (13); graphite moderated (4); and fast research reactors (6). The *Directory* is available from IAEA sales agents, or directly from IAEA, Kärntnerring, Vienna 1, Austria. The price of volume 3 is $4.

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Life sciences. The Atomic Energy Commission has published the second in a series of pamphlets describing its life sciences research program, which is directed toward the accumulation of knowledge of the effects of nuclear radiation from any source, natural or man-made, upon living things. The booklet, *Genetics Research*, was prepared under the direction of the commission's Division of Biology and Medicine. It summarizes work in progress at 49 institutions under 101 research contracts or projects. The publication is available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.; price per copy, $1.25. (The first pamphlet in this series, *Marine Sciences Research*, may be purchased from OTS at 50 cents a copy.)

Grants, Fellowships, and Awards

Agricultural chemistry. The Association of Official Agricultural Chemists has announced that nominations are now being accepted for the fifth AOAC Harvey W. Wiley Award for Achievement in Analytical Methods. This award of $500 will be given to the scientist or group of scientists who have made outstanding contributions to the development of analytical methods in the fields of foods, drugs, cosmetics, feeds, fertilizers, and pesticides or for use in general analytical chemistry. These are the fields dealt with in the AOAC publication, *Official Methods of Analysis*, the primary laboratory manual of regulatory chemists and research workers in agriculture in the United States and throughout the world.

Nominations must be submitted *by 1 April* to the association secretary, William Horwitz, Box 540, Benjamin Franklin Station, Washington 4, D.C.

Chemistry teachers. The Manufacturing Chemists' Association has announced its 1961 College Chemistry Teacher Awards program, which will honor six outstanding college chemistry teachers throughout the United States. Medals and citations, accompanied by $1000 awards, will be presented at the

association's annual meeting, 8 June 1961, at White Sulphur Springs, W. Va. Two awards will be granted in each of three regions into which the United States has been divided by the selection committee.

To be eligible for nomination for an award, a teacher must have had at least 10 years' service in undergraduate teaching in chemistry, chemical engineering, or allied courses. He must be nominated by the president of the college or university where he is teaching, and this must be an accredited college or university offering 4-year bachelor degrees. However, there is no requirement for a minimum length of service at the institution from which he is nominated.

In reviewing a nomination the judges will consider convincing evidence that the nominee has been personally responsible over a period of years for awakening in students a genuine interest in chemistry, for inspiring them to make serious intellectual effort in that field, and for developing that interest into a continuing dedication. All nominations must be submitted *by 1 April* to the Manufacturing Chemists' Association, 1825 Connecticut Ave., NW, Washington 9, D.C.

Gravity. The Gravity Research Foundation has announced its 1961 Awards for Essays on Gravity. Five awards will be made on 1 June for the best 1500 word essay on the possibilities of discovering: (i) some partial insulator, reflector, or absorber of gravity; (ii) some alloy, or other substance, the atoms of which can be agitated or rearranged by gravity to throw off heat; or (iii) some other reasonable method of harnessing, controlling, or neutralizing gravity. The awards will be in amounts of $1000, $300, $200, $150, and $100.

Essays must be received *before 15 April*. For detailed information write to: Gravity Research Foundation, New Boston, N.H.

Neurology. The National Neurological Research Foundation is now accepting applications for its senior fellowships in neurology, which carry stipends of $12,000 a year for 5 years. Fellowships may be activated through 31 December 1961. Awards will be announced at the meeting of the American Neurological Association in June 1961. For further information, write the National Neurological Research Foundation, 3255 N St., NW, Washington 7, D.C.

Ophthalmology. The National Council to Combat Blindness, Inc.—The Fight for Sight, 41 W. 57 St., New York, N.Y.—makes annual awards in support of ophthalmic research. Fight for Sight grants-in-aid and full-time research fellowships are generally awarded for a period of 1 year, and may be renewed. Student fellowships are awarded for a 2- or 3-month period to students of medicine and the basic sciences, providing them with an opportunity to engage in research between semesters.

Reproductive physiology. In recognition of the world-wide need for scientific training in reproductive physiology, the Worcester Foundation for Experimental Biology plans to continue its postdoctoral program in this field under a grant from the Population Council. Starting in 1962, the annual program will commence on 1 February.

Fellowships will be awarded to candidates holding the Ph.D. or M.D. degree, or the equivalents. These fellowships will carry a stipend of $5500 per annum and will be for a 12-month period. An allotment will also be made for round-trip travel to Shrewsbury, Mass.

The application deadline is *1 June*. Application forms and information may be secured at any time from the program director, Celso-Ramon García, Worcester Foundation for Experimental Biology, Shrewsbury, Mass. However, applications will not be acted upon prior to the given date for the particular year selected.

Whenever possible, arrangements should be made for an interview with a member of the advisory and selection committee, which includes: Dr. Gregory Pincus, research director of the Worcester Foundation; Dr. Warren O. Nelson, The Population Council, Inc., Rockefeller Institute, 66th St. and York Ave., New York 21, N.Y.; Dr. V. R. Khanolkar, Indian Cancer Research Centre, Parel, Bombay 12, India; Dr. Roberto Caldeyro-Garcia, Facultad de Medicine, Avenida Gral Flores, 2125, Montevideo, Uruguay; Dr. Takeshi Nakao, Tokyo Jidei-kai School of Medicine, Atago-cho, Shiba, Minato-ku, Tokyo, Japan; and Dr. M. C. Shelesnyak, Weizmann Institute of Science, Post Office Box 26, Rehovoth, Israel.

Travel. Limited funds are available from the National Science Foundation for the support of travel by U.S. scientists to international scientific congresses. The grants will approximately cover round-trip, air-tourist fare between the recipient's home institution and the location of the meeting. Application forms may be obtained from the Division of Mathematical, Physical and Engineering Sciences, National Science Foundation, Washington 25, D.C. The following congresses are among those that have been selected for support:

European Molecular Spectroscopy group in Amsterdam, Holland, 29 May–2 June. *Closing date: 20 March.*

International Association of Quaternary Research, Warsaw, Poland, 2–7 September. *Closing date: 1 April.*

International Cloud Physics Conference, in Canberra and Sydney, Australia, 11–21 September. *Closing date: 1 April.*

Scientists in the News

Norman D. Newell has been named the recipient of the Mary Clark Thompson Medal of the National Academy of Sciences in recognition of his outstanding contributions to paleontology and geology, and particularly to the ecology of modern and ancient calcareous reefs. Newell is chairman and curator of the Department of Fossil Invertebrates at the American Museum of Natural History in New York and a professor of geology at Columbia University. The award will be presented to him during the academy's annual meeting, to be held in Washington on 24 April.

Norman D. Newell. [Fabian Bachrach]

Warren S. Wooster, formerly associate research oceanographer at the University of California's Scripps Institution of Oceanography, has left for Paris, where he will head UNESCO's recently established Office of Oceanography.

The Office of Oceanography was authorized by the UNESCO Council in November. At the same time, the council set up an Intergovernmental Oceanographic Commission. The aim of both bodies is to foster international cooperative research in the marine sciences. As director of the Office of Oceanography, Wooster will serve as secretary of the commission.

Physicist **Richard F. Humphreys** has been named president of the Cooper Union for the Advancement of Science and Art in New York City, effective 1 June. He is now vice president of the Armour Research Foundation, Illinois Institute of Technology, Chicago. Humphreys succeeds **Edwin S. Burdell**, who retired in February 1960 to become president of the Middle East Technical University in Ankara, Turkey, after 22 years as director and president of Cooper Union.

Wendell M. Stanley, director of the University of California's Virus Laboratory, Berkeley, arrived in Europe this month to begin an 8-month study tour on a Guggenheim fellowship. Through visits to laboratories in ten European cities, he hopes to strengthen and extend international scientific cooperation in the field of virus research.

The following men will lecture at a number of colleges and universities during March as Sigma Xi national lecturers.

Theodosius Dobzhansky, Dacosta professor of zoology, Columbia University, will discuss "Man and Natural Selection."

Norman F. Ramsey, professor of physics at Harvard University, will discuss "Nuclear Interactions in Molecules."

Sanborn C. Brown, associate professor of physics at Massachusetts Institute of Technology, will discuss "Plasma Physics."

C. Jolliffe, deputy director of the Grants Division of Great Britain's Department of Scientific and Industrial Research, London, will be in the United States and Canada from 28 March to 8 May. He is primarily interested in the handling of problems arising from government support of universities and technical institutions. He will visit Washington (30 March–5 April, and 4–7 May); Baltimore; Raleigh, N.C.; the Boston area; and Ottawa and Montreal, Canada.

Among the six women with outstanding careers in government selected as winners of the first annual Federal Women's Award were two scientists—**Charlotte Moore Sitterly**, physicist with the National Bureau of Standards, Washington, D.C., and **Rosslyn S. Yalow**, principal scientist, Radioisotope Service, Veterans' Administration Hospital, Bronx, N.Y.

At Stanford University School of Medicine, **Thomas A. Stamey**, associate professor of urology at Johns Hopkins University Medical School, has been appointed associate professor of surgery and will head the new division of urology in the department of surgery. **Tag Eldin Mansour**, associate professor in the department of pharmacology at Louisiana State University, has been appointed professor of pharmacology.

Maurice J. Murray, chemical consultant to the Universal Oil Products Co., Des Plaines, Ill., has been appointed chief scientist of the U.S. Army Chemical Corps. He will report for duty on 1 March. Prior to joining Universal Oil, Murray was professor of chemistry and acting chairman of the department of chemistry at Illinois Institute of Technology.

William N. Parkinson, vice president in charge of the Temple University Medical Center, is retiring after more than 35 years of service. Parkinson, who has held various posts at Temple, was for 30 years dean of the Medical School, from which he was graduated in 1911.

Louis Gordon, professor of chemistry and a well-known analytical chemist, has been appointed dean of graduate studies at Case Institute of Technology. The appointment will be effective 1 July, when **Eric Arnold**, at present associate dean, reaches the mandatory retirement age for administrative personnel. Arnold will continue as professor of chemistry.

James A. Krumhansl, professor of physics at Cornell University, has been appointed director of Cornell's Laboratory of Atomic and Solid State Physics, succeeding **Robert L. Sproull**, who was recently named director of the Cornell Materials Science Center.

Lauriston Sharp, distinguished anthropologist, has been appointed visiting professor of anthropology for the 1961–62 academic year at the University of California, Berkeley. Sharp is an authority on the cultures of Southeast Asia.

Recent Deaths

Lyman Allen, Burlington, Vt.; a past president and a founder of the American College of Surgeons and emeritus professor of surgery at Vermont College of Medicine; 2 Feb.

Larry R. Commissaris, Tucson, Ariz.; zoologist; was doing graduate work in the department of zoology at the University of Arizona; 17 Jan.

Rev. Dr. **Etienne Drioton**, Paris, France; 71; archeologist and well-known Egyptologist who was named head curator of Egyptian antiquities of the Louvre Museum in 1952; worked in Egypt for 28 years, but at the time of the Egyptian *coup d'état* of 1952 was dismissed from his posts as director general of the Department of Egyptian Antiquities in the Ministry of Education and director of the Egyptian Museum in Cairo; 19 Jan.

Robert H. Kent, Havre de Grace, Md.; 75; physicist and a leader in modern ballistics, who worked at the Army's Proving Ground Ballistics Laboratory for 34 years before retiring in 1956; for many years was chairman of the explosives and armament panel of the Air Force Scientific Advisory Board; 3 Feb.

Meyer Mendelsohn, New York, N.Y.; 65; chemical engineer; vice president of Yardney Chemical, Inc., and head of chemical research for the Yardney International; early developer of ion-exchange separators, used in silver-zinc batteries for missile, satellite, and other applications; 14 Feb.

Jerome T. Syverton, Minneapolis, Minn.; 53; professor and head of the department of bacteriology, University of Minnesota; distinguished teacher and investigator in virology and cell biology; 28 Jan.

Book Reviews

The Child Buyer. A novel in the form of hearings before the Standing Committee on Education, Welfare, and Public Morality of a certain state Senate, investigating the conspiracy of Mr. Wissey Jones, with others, to purchase a male child. John Hersey. Knopf, New York, 1960. 257 pp. $4.

John Hersey has an infallible ability to put his finger on the rawest spots in contemporary society, as he did with his discussions of the Warsaw ghetto and Hiroshima. This book, based on more than a decade of interest in gifted children and participation in local and national deliberations on education, brings into sharp and shocking conjunction two salient aspects of our present attitudes: our willingness to treat people as things—"the human component in systems design"—and our interest in the gifted child—whom otherwise a democratic society would prefer to ignore—as a defense need. Three decades ago, in Aldous Huxley's "The Young Archimedes," the child, lonely after he had been "bought" from his peasant family, commits sorrowful suicide; and Wells's "Invisible Man" performed experiments on himself, defying society on his own behalf. In this 1960 version we are pictured as having come much further. A large defense plant, significantly and inappropriately charged with planning for human beings, sends out scouts to purchase, by whatever morally corrupt means, those very exceptional children who lie outside the normal range of high general intelligence. The buyer explains that the child will first be scientifically treated so that all memory of his previous identity is lost; and later, after he has been "programmed," his sensory inputs will be cut off; and he will become indeed just a human component in a vast computing machine. Here a nightmare fantasy of science fiction, well represented, for example, by Pohl and Kornbluth's *Wolfbane* (1959), invades the field of literature, doubtless safely, since the public have been steadily anesthetized by accounts of experimental brainwashing and sensory deprivation experiments and of observations made on human beings which violate their privacy and their human dignity. The child himself, one of those strange chunky, waistless, peering children who turn up rarely as "infant prodigies," is allowed a mockery of the democratic privilege of choice. Hounded and betrayed by parents and teachers and the elected representatives of the people, he "elects" surrender—with no less desperation than the blue-eyed little mathematician of Huxley's story—not to the simplicity of death, but to the absolute violation of his beautiful scientific mind. Coming as he does from a poor and disorganized home, there is no place for him in a school system which is dominated by ideas of adjustment and normality, or in a society which indulges a cheap sense of virtue by helping the handicapped, but takes an insensate delight in punishing the gifted even when they are needed for national defense. Perhaps the most horrible touch is the betrayal by the one teacher who has genuine scientific curiosity and is able to appreciate the child's great ability, but who has come up the hard way and learned to value success even more, so that she sees the boy as bright enough to beat the system into which he is being sold.

A Moral Problem

The book should be read by everyone interested in science, in education, and in our deteriorating ethical sensitivity. It raises one further very important problem about the nature of this particular type of child genius, who is described so accurately that anyone who has known one will recognize him at once. Such children have proportionately large heads, are somewhat obese, often myopic. They combine extraordinary intellectual abilities with a kind of frightening ruthless clarity, and while their mental performance equals and often surpasses that of superior adults, there is a childlike quality about their human relationships; pure curiosity or pure ethical concern seems to occur uncomplicated by the type of learning which most human beings experience at puberty. It is not only their "giftedness" but also their detachment and their use of intellectual superiority as the only defensive weapon available to them—for their over-all motor coordination is poor—that make them, at best, objects of indifference and distaste, and, at worst, of persecution.

Research is urgently needed so that we may identify and protect these children, some of whom go to pieces in their late teens. We need to know whether their peculiar and characteristic somatic traits are indicative of some difference in growth rate and nutrition —aggravated when they come from poor environments—and whether they represent some discrepancy between maturation of the brain and the reproductive system, possibly characteristic of some earlier evolutionary form, which now gives them a strange advantage over their more slowly maturing fellows. We need to know what is the relationship of this group to another familiar type of mathematical genius, the tall ectomorphic child who matures very late and may retain an adolescent somatotype until middle age, displaying, in contrast to the squarish precocious child, an extreme prolongation of maturation. These children also suffer at the hands of their schoolmates.

The presence of geniuses so far outside the normal range probably decreases the performance of the superior child whose physique is closer to the average. For their own sake and for the sake of the others, these genius children should be sought for, identified, and placed in special contexts where their minds can develop at their own pace. Norbert Wiener's *Ex-prodigy* tells the story of one extremely gifted child whose father was willing and able to teach him. For the child without such parents, the whole community of learning should provide nurture and protection.

MARGARET MEAD
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A Bibliography of Dr. Robert Hooke. Sir Geoffrey Keynes. Oxford University Press, New York, 1960. xix + 115 pp. Illus. $8.

Robert Hooke (1635–1703) has the distinction of having been the first lowly man to earn his living as a research scientist. Having worked his way through school and college, he started as a teen-age laboratory assistant, first to an Oxford physician, then to Robert Boyle, and last to the newly formed Royal Society where he became "curator of experiments" in 1662. Many before (and since) had dreamed of an idealized research institute where men of learning could cogitate and muse and have their tests and trials and experiments of light performed for them by a paid hack. In an age when all science was on the boil, Hooke was the God-sent hack of those mid-17th century amateurs of science; and hack he was in name only, but not in deed. Though much of his work was forgotten within a generation or so of his death, and though he was remembered only as a misshapen and cantankerous minor character on the stage, his discoveries and writings are now seen to class him among the major actors in that age of genius.

The last 30 years have seen many critical studies of Hooke and appreciations of his experimental work and publications. These studies are now taken to a new level of excellence by this definitive bibliography compiled by Sir Geoffrey Keynes, doyen of British bibliography. The handsome volume, produced in the style which one has come to expect of Sir Geoffrey and of Oxford, has all the scholarly apparatus needed for its task, though one could wish that the quintessential introductory essay of the preface had been expanded by the factor of ten, which we all know the author could easily do. To make up for this, however, we are given gratis, as appendix 4, a most interesting transcript of Sir Isaac Newton's holograph notes on Hooke's *Micrographia*.

One of the most interesting puzzles set by the new bibliography is that of Hooke's fourth (or second) publication in 1661 of a tract entitled "A discourse of a new instrument to make more accurate observations in astronomy, than ever were yet made." No copy of this publication has yet been traced, but from the title, one might hazard a guess that this was an account of the eyepiece micrometer similar to that of Gascoigne, improved by Townley, and noted later by Hooke.

Like Fulton's bibliography of Robert Boyle, with which this bibliography has so much in common, both in content and in spirit, this new work will stand for many years as an aid to historians, collectors, and librarians, and as a point of departure for many essays in scholarship. We are most grateful to the author for his exemplary and meticulous execution of a most useful task.

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Antarctica. Emil Schulthess. Simon and Schuster, New York, 1960. Approximately 215 pp. Illus. $15.

Following the preface, in which Sir Raymond Priestley recounts his voyages to Antarctica (in 1908, 1910, 1956, and 1958) and tells of the changes made there during the interval, and Rear Admiral Dufek's account of Operation Deep Freeze IV, Emil Schulthess presents a photographic documentation of the antarctic continent. He begins with a view of the antarctic coast of Victoria Land, which was "seen for the first time in 1840 by Sir James Clark Ross," and shows the equipment, ranging from Super-Constellations to Sno-Cats, used by those who work at the antarctic bases. In over 170 photographs, many of them in color and covering a full page or more, he shows such things as "a natural laboratory" (an 85-foot crevasse), men and their equipment silhouetted against a "halo in the sky," Sastrugi (wave-like ridges of hard snow), and the animal and plant life of the region.

Henry M. Dater gives a brief account of science in Antarctica.

Albert Jan Kluyver. His life and work. A. F. Kamp, J. W. M. La Rivière, and W. Verhoeven, Eds. North-Holland, Amsterdam; Interscience, New York, 1959. xv + 567 pp. Illus. $11.

This volume, a memorial to Jan Kluyver (1888–1956), is divided into three parts. In the first, friends and former associates present a biography of Kluyver and a survey of his work; in the survey, C. B. van Niel combines admiration with amiable criticism. Part 2 consists of 14 selections from Kluyver's papers; they range from the inaugural address (1922) made when he succeeded M. W. Beijerinck to the chair of microbiology at the Technical University of Delft to the last general lecture that he made before the academy of sciences in Amsterdam (1955). An extensive bibliography and addenda are included.

Kluyver, who studied chemistry under J. Böeseken and miscroscopic anatomy under G. van Iterson, always emphasized the value of combining biochemistry with morphology; on this basis he proposed (in 1936) a "natural system" for classifying bacteria. This specialist, who discovered that diacetyl was the flavoring agent of butter [with van Niel and H. G. Derx (1929)] and who originated the method of submerged culture [with L. H. C. Perquin (1933)] was also deeply interested in the great problems of the scientific knowledge of life. He sought "unity in the wild variety of nature," and when he realized that his "unitary theory" (1924) was deficient, he began to see "the possibility of an even greater simplification and unification" of our views on metabolism. This quotation is from his lectures given at Harvard University (1954).

This book, about the man who said "There is but one enemy of homo sapiens . . . homo ignorans," will be of great interest to biochemists and microbiologists.

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Louisiana Birds. George H. Lowery, Jr. Published for the Louisiana Wild Life and Fisheries Commission by Louisiana State University Press. Baton Rouge, ed. 2, 1960. xxix + 567 pp. Illus. $7.50.

Birds of Hawaii. George C. Munro. Bridgeway Press, 1944; Tuttle, Rutland, Vt., 1961. 189 pp. Illus. $4.50.

Louisiana Birds is a revised edition of a volume published in 1955. The fact that the original printing was exhausted and a revision was necessary in such a short time (5 years) indicated the stimulus given by the book to the study of ornithology in Louisiana. No less than ten species have been added to the state list since 1955; not only are they de-

scribed and discussed in the present edition, but the accounts of many times that number of other birds have also been revised in keeping with new data accumulated since the book was first published. The nomenclature throughout has been revised where necessary to conform with the latest edition of the *Check-list of North American Birds* (American Ornithologists' Union, 1957). It seems obvious that this fine volume will continue to be useful.

Birds of Hawaii is a new printing of a book first published in 1944; it has been out of print for a long time and, consequently, was difficult and costly to obtain. When Hawaii became a state, it was felt that the occasion justified publishing a revision of the only modern compendium and manual for studying the bird life of the new state. The chief alterations in this printing are the addition of a handy list of all the changes made since 1944 in the classification and nomenclature of the birds and the replacement of some of the less satisfactory illustrations found in the original printing. If and when a new edition is published, I hope it will have better color plates. The ones in the present volume are not good enough for a state bird book; the text is far better than the plates.

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New Books

Mathematics, Physical Sciences, and Engineering

Alluvial Prospecting and Mining. S. V. Griffith. Pergamon, New York, ed. 2, 1960. 255 pp. Illus. $7.50.

Annual Review of Nuclear Science. vol. 10. Emilio Segrè, Ed. Annual Reviews, Palo Alto, Calif., 1960. 624 pp. Illus. $7. Contains 15 articles written by 22 contributors, including articles by F. Reines on neutrino interactions, H. Bradner on bubble chambers, J. G. Beckerley on methods for subsurface prospecting, and R. C. Thompson and J. B. Storer and D. Grahn on vertebrate radiobiology.

Automation. Its impact on business and people. Walter Buckingham. Harper, New York, 1961. 206 pp. $4.50.

Axiomatics of Classical Statistical Mechanics. Rudolf Kurth. Pergamon, New York, 1960. 190 pp. Illus. $7.50.

Basic Mathematics of Science and Engineering. Reuben E. Wood. Sigma Press, Washington, D.C., 1960. $2.50.

Cermets. J. R. Tinklepaugh and W. B. Crandall, Eds. Reinhold, New York; Chapman and Hall, London, 1960. 245 pp. Illus. $9.50.

Combinatorial Analysis. vol. 10, Proceedings of Symposia in Applied Mathematics. American Mathematics Soc. Providence, R.I., 1960. 317 pp. Illus.

Comprehensive Analytical Chemistry. vol. 1B, *Classical Analysis*. Cecil L. Wilson and David W. Wilson, Eds. Elsevier, Amsterdam, 1960 (order from Van Nostrand, Princeton, N.J.). 900 pp. Illus. $30.

Contributions to the Theory of Nonlinear Oscillations. vol. 5. L. Cesari, J. LaSalle, and S. Lefschtez. Princeton Univ. Press, Princeton, N.J., 1960. 296 pp. $5.

Crystal Structures. vol. 5. Ralph W. G. Wyckoff. Interscience, New York, 1960 (not folioed). Chapters 14 and 15 and the "Index to organic compounds."

Electromagnetic Fields and Waves. Robert V. Langmuir. McGraw-Hill, New York, 1961. 236 pp. Illus. $9.75.

Electronics for Children. Gabriel Reuben. Sterling, New York, 1960. 88 pp. Illus. $2.50.

Eléments de Physique Nucléaire. Daniel Blanc and Georges Ambrosino. Masson, Paris, 1960. 238 pp. Illus. NF. 30.

Fast Reactor Cross Sections. A study leading to a 16 group set. S. Yiftah, D. Okrent, and P. A. Moldauer. Pergamon, New York, 1960. 135 pp. Illus. $5.

Foundations of Geometry. Euclidean and Bolyai-Lobachevskian geometry, projective geometry. Karol Borsuk and Wanda Szmielew. North-Holland, Amsterdam; Interscience, New York, 1960. 444 pp. $12.

From Theory to Practice in Soil Mechanics. Selections from the writings of Karl Terzaghi. L. Bjerrum, A. Casagrande, R. B. Peck, and A. W. Skempton. Wiley, New York, 1960. 433 pp. $12. Contains a bibliography and "contributions on [Terzaghi's] life" by Bjerrum *et al.*

Fundamental Physics. Jay Orear. Wiley, New York, 1960. 1961. 395 pp. Illus. $6.75.

Fundamentals of Aerodynamic Heating. Robert Wesley Truitt. Ronald, New York, 1960. 269 pp. Illus. $10. From the preface: "This book is an introduction to the subject . . . developing . . . the theoretical background necessary to a fundamental understanding of laminar and turbulent boundary layers and their relation to skin friction and heat transfer." Truitt is professor and head of the department of aeronautical engineering at Virginia Polytechnic Institute.

Handbook of Textile Testing and Quality Control. Elliot B. Grover and D. S. Hamby. Textile Book Publishers, Interscience, New York, 1960. 620 pp. Illus. $17.50.

How To Use Algebra in Everyday Life. By the editors of the Sterling Publishing Co. Sterling, New York, 1960. 253 pp. Illus. $3.95.

Hydrodynamics. A study in logic, fact and similitude. Garrett Birkhoff. Princeton Univ. Press, Princeton, N.J., rev. ed., 1960. 196 pp. Illus. $6.50.

Inorganic Chemistry. Jacob Kleinberg, William J. Argersinger, Jr., and Ernest Griswold. Heath, New York, 1960. 688 pp. Illus. $10.75.

Inorganic Syntheses. vol. 6. Eugene G. Rochow, Ed. McGraw-Hill, New York, 1960. 283 pp. $7.75.

An Introduction to Astronomy. Robert H. Baker. Van Nostrand, Princeton, N.J., ed. 6, 1961. 372 pp. Illus. $5.50.

Introduction to Atomic and Nuclear Physics. Otto Oldenberg. McGraw-Hill, New York, ed. 3, 1961. 393 pp. Illus. $7.95.

An Introduction to Celestial Mechanics. Theodore E. Sterne. Interscience, New York, 1960. 217 pp. Illus. Cloth, $4.50; paper, $2.50.

Introduction to Ceramics. W. D. Kingery. Wiley, New York, 1960. 799 pp. Illus. $15.

Introduction to Nuclear Science. Alvin Glassner. Van Nostrand, Princeton, N.J., 1960. 223 pp. Illus. $3.75.

Introduction to Quantum Mechanics. Robert H. Dicke and James P. Wittke. Addison-Wesley, Reading, Mass., 1960. 380 pp. Illus. $8.75.

Lead Isotopes in Geology. R. D. Russell and R. M. Farquhar. Interscience, New York, 1960. 251 pp. Illus. $9.

Lectures on Differential and Integral Equations. Kosaku Yosida. Interscience, New York, 1960. 230 pp. $7. The English edition, prepared by Shigeharu Harada, is a translation of a volume originally published in the series "Iwanami Zensho."

Linear Systems Analysis. An introduction to the analysis of discrete-parameter time-invariant linear systems. Paul E. Pfeiffer. McGraw-Hill, New York, 1961. 555 pp. Illus. $12.50.

Mechanical Waveguides. The propagation of acoustic and ultrasonic waves in fluids and solids with boundaries. Martin Redwood. Pergamon, New York, 1960. 309 pp. Illus. $9.

Modern Factor Analysis. Harry H. Harman. Univ of Chicago Press, Chicago, Ill., 1960. 485 pp. Illus. $10.

New Mathematics. A unified course for secondary schools. vol. 2. K. S. Snell and J. B. Morgan. Cambridge Univ. Press, New York, 1960. 320 pp. Illus. $2.25.

Organic Electronic Spectral Data. vol. 1, 1946–1952. Mortimer J. Kamlet, Ed. vol. 2, 1953–1955. Herbert E. Ungnade, Ed. Interscience, New York, 1960. vol. 1, 1222 pp., $25 (subscription price); $28.50. vol. 2, 929 pp., $17.50. (subscription price); $15. From the preface material: "In order to be included, the data had to satisfy the following minimum requirements: The investigated compound must be sufficiently pure to give satisfactory analyses and definable by a molecular formula. The solvent or phase should be stated and the spectral data complete enough so that wavelengths of maximal absorption and molar absorptivities could be computed even if they were not stated in the original publication. Later, it was decided to include data for which no solvent was given, provided spectral data with solvents did not exist for such compounds." Volumes 3 and 4 are scheduled for publication.

Oxosteroids. The use of phenolic hydrazides for detection, characterisation, and estimation. Bernard Camber. Lewis, London, 1960. 79 pp. Illus. 12s. 6d.

Physical Methods of Organic Chemistry. vol. 1, pt. 4 of *Technique of Organic Chemistry*. Arnold Weissberger, Ed. Interscience, New York, ed. 3, 1960. 1081 pp. Illus. $26.

Reports

An Interpolated Molecular Formula

Abstract. The necessity of counting hydrogen atoms in molecular formulas may be obviated by substituting a "hydrogen reciprocal," which can be obtained more easily.

When molecular formulas are used for searching or filing chemical compounds, handling of the hydrogen atoms proves troublesome. Counting the H's is laborious and is responsible for the majority of errors in these formulas; yet, the sum of the H's does not provide much information about a compound. As a result, this sum has been relegated to the end of the formulas in some collections (*1*) and in others it has been omitted altogether (*2*).

I propose, here, to omit the sum of hydrogen atoms from molecular formulas of covalent compounds and to replace it with the number of rings and the degree of unsaturation of the molecules. It has already been shown that, mathematically, these two expressions are equivalent (*3*, *4*).

A few examples of the proposed interpolated formulas are given below, along with their conversion into conventional molecular formulas. In the proposed formulas, the number before the comma represents the number of rings, R, and the number after the comma represents the degree of unsaturation, Δ. This choice of two numbers is arbitrary. One alternative is to use a set of three numbers: f for the number of double bonds connected to hetero atoms (as in >C═O); s for the number of double bonds linking carbon atoms (as in >C═C<); and R for the number of rings. Such division is a matter of convenience. If the three numbers f, s, and R are used, the expression will be different for keto and enol tautomers. On the other hand, if R and Δ (which is $f + s + R$) are added to form a single number [Soffer's ρ (*4*), which here may properly be called a hydrogen reciprocal], the expression will remain unaltered even if the represented compound undergoes glycoside formation.

From an equation derived by Soffer (*4*), the conversion formula is obtained. In its general form, it is Eq. 1:

$$n_H = 2 + \Sigma\, n_v(v - 2) - 2(R + \Delta) \quad (1)$$

where n_v is the number of atoms (except hydrogen atoms) of covalence v, the sum of which is taken over all the v's; n_H is the number of hydrogen atoms; R is the number of rings; and Δ is the number of double bonds (one triple bond counts for two double bonds; unsaturated linkages in functions are counted too) (*5*).

In most cases, Eq. 1 will reduce to the following:

$$n_H = 2 + 2n_C + n_{N,P} - n_{Hal} - 2(R + \Delta) \quad (2)$$

where n_C is the number of carbon atoms, $n_{N,P}$ is the number of (trivalent) N and P atoms, and n_{Hal} is the number of halogens. For example:

1) For ergosterol, the interpolated formula is $C_{27}O$-4,3. To find n_H, substitute into Eq. 2 the values $n_C = 27$, $R = 4$, and $\Delta = 3$: $n_H = 2 + 2 \times 27 - 2(4 + 3) = 42$. The molecular formula is $C_{27}H_{42}O$.

2) For riboflavin phosphate, the interpolated formula is $C_{17}N_4O_9P^V$-3,8 (see *5*). To find n_H, substitute into Eq. 2 the values $n_C = 17$, $n_N = 4$, $R = 3$, $\Delta = 8$, and $n_{P^V} = 1$: $n_H = 2 + 2 \times 17 + 4 - 2(3 + 8) + 3 \times 1$ ($= 3n_{P^V}$, Eq. 1) $= 21$. The molecular formula is $C_{17}H_{21}N_4O_9P$.

3) Attention must be paid to abnormal valencies; in carbon monoxide, for instance, $2n_C$ does not apply, since $v = 2$ here and the $n_C(v - 2)$ from Eq. 1 becomes 0.

It is seen that the advantages of interpolated formulas are that no information is lost, and that these formulas are more meaningful, more easily obtained, and less apt to contain errors than conventional formulas. Furthermore, interpolated formulas can be obtained for many compounds with unknown structures, as enough data for their calculation are often available at an early stage. For other compounds, the conventional molecular formulas could be filed, without inconvenience, among interpolated formulas. The presence of hydrogen simply would indicate the lack of other information.

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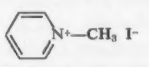
References and Notes

1. J. H. Fletcher and D. S. Dubbs, *Chem. Eng. News* **34**, 5888 (1956); G. M. Dyson, *Chem. & Ind. (London)* **1952**, 676 (1952).
2. H. Skolnik and J. K. Hopkins, *J. Chem. Educ.* **35**, 150 (1958).
3. A. A. Pontet, *Chimia (Switz.)* **5**, 39 (1951).
4. M. D. Soffer, *Science* **127**, 880 (1958).
5. In the file now in use in our department at Walter Reed, some simplifications have been introduced. For elements that can exhibit several valencies, the "normal" one is recorded (that is, 3 for N and P, 2 for S), provided that the additional valencies consist of double bonds. These double bonds may then be disregarded. Thus, the formula for CH_3—NO_2 is CNO_2-0,1; for CH_3—SO_3H it is CO_3S-0,0, and for riboflavin phosphate it would be $C_{17}N_4O_9P$-3,7. However, in 1-methylpyridinium iodide,



the additional valencies do not consist of a double bond; therefore, the formula is C_6INV-1,3.

2 August 1960

Syphacia muris, the Rat Pinworm

Abstract. A migration of gravid *Syphacia muris* pinworms down the large intestine of the rat host is shown to occur from the seventh day on in the worm's life cycle. Eggs obtained from migrating worms have proved to be infective to helminth-free rats after incubation in saline for 30 minutes at room temperature and 4 hours at 37°C.

The pinworm, *Syphacia muris*, is a very common cecal parasite of the laboratory albino rat. Few details of the life history of this pinworm are known, however, mainly because previous workers (*1*) have been unable to obtain infective stages of the parasite for use in experimental infections. These investigators reported that eggs liberated from gravid worms taken from the cecum of infected rats would not continue their development in vitro. Chan (*2*), using the closely related mouse pinworm *S. obvelata*, then demonstrated that eggs obtained from gravid female worms migrating down the colon of the host mice at the conclusion of their life cycle would develop to the infective stage. This suggested that

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Table 1. The distribution of *Syphacia muris* in the intestine of albino rats.

T(day)*	Rats (No.)	Worm burdens		Anal swabs
		Cecum	Colon	
1	2	386	0	–
2	2	367	0	–
3	4	635	7	–
4	4	170	0	–
5	4	620	6	–
5½	4	218	0	–
6	4	760	15	–
7	4	270	25	+
7½	4	130	119	+
8	4	133	11	+
9	4	41	3	+
9½	4	61	0	+
10	4	7	3	+

* Time after exposure to infection.

knowledge of the period of migration of *S. muris* down the rat's intestine would greatly facilitate the recovery of large numbers of gravid "migrators" as a source of infective eggs.

Forty-eight helminth-free albino rats, 3 to 5 weeks old, were placed for 24 hours in contaminated cages containing heavily infected *S. muris* "source" rats. This procedure is a modified version of Chan's (*3*) technique for infecting mice with *S. obvelata*. At periodic intervals thereafter, Scotch tape anal swabs were taken from each rat and examined for the presence of *S. muris* eggs, then two or four rats were killed and their pinworm burdens were determined.

Table 1 summarizes the results of this study. The migratory phase of the *S. muris* life cycle began on the sixth to seventh day after infection, as determined by autopsy findings and the presence of eggs on the perianal regions of the rats. During the seventh and eighth days, maximal numbers of gravid migrators were found in the colon of the rats. Many of the migrating female worms spontaneously shed their eggs on exposure to air or to saline solution. In addition, a small number of gravid nonmigrating female worms, from the cecum, also shed their eggs upon exposure. These spontaneously shed eggs were infective to rats after incubation in saline for periods ranging from 30 minutes at room temperature to 4 hours at 37°C (*4*).

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9 September 1960

Low Temperature Induced Male Sterility in Male-Fertile Pennisetum clandestinum

Abstract. Controlled environment studies of *Pennisetum clandestinum* showed that at 10°C stamens of the male-fertile strain were not exserted from the floret although stigmas emerged normally. At higher temperatures both stamens and stigmas were exserted. Pollen abortion was high at 10°C and was increased by lengthening photoperiod. Flowering of the male-sterile strain was not changed by any temperature or photoperiod. These responses to temperature may explain the natural sterility during the cool season.

Pennisetum clandestinum, introduced to the United States about 1920, consists of male-sterile and male-fertile strains. The inflorescences of the two strains have been described by Edwards (*1*) and Narayan (*2*). Anthers of the male-sterile strain are retained in the leaf sheath enclosing the flower and contain no viable pollen. Anthers of the male-fertile strain are exserted from the enveloping sheath on long filaments. Stigmas are exserted in both strains throughout the year in the Los Angeles area, but few or no stamens emerge during the winter in the male-fertile strain. I observed approximately 25 percent nonstaining (sterile) pollen during the summer and 50 percent or more in the winter in the fertile strain. No stainable pollen was observed in the sterile strain at any season (*3*).

Anther abortion in wheat by chilling was demonstrated by Suneson (*4*). Nitsch *et al.* (*5*) reported deformed male flowers in Cucurbitaceae as well as a reduction in the proportion of male flowers when temperatures were reduced from 26°C to 20°C. The purpose of this study was to determine if the seasonal changes in sex expression of *P. clandestinum* were caused by changes in temperature or photoperiod.

Plants of *P. clandestinum* were propagated in 5-in. pots from a male-sterile and a male-fertile clone. All plants were kept in a 21°C minimum temperature greenhouse. As the plants developed they were clipped frequently to stimulate flowering (*6*). At full flowering, they were transferred to controlled environment growing chambers under 8- and 16-hour photoperiods at the following temperatures centigrade: 27°, 10°, and 21° minimum for days to 10° for nights. Plants, given the alternating temperature and 16-hour photoperiod, received 8 hours of light at the day temperature and 8 hours at the night temperature. In addition, two lots of plants were given continuous light at 27° and 10°C. Five plants of each clone were placed in each treatment.

Flowering behavior was noted periodically as the treatment progressed. After 4 weeks in the growing chambers, pollen fertility was determined by staining with acetocarmine (*7*). Three inflorescences from each plant were examined.

Observation of the male-fertile strain showed a pronounced reduction in the number of florets with exserted stamens between the second and third week in the 10°C treatments. Table 1 shows that by the fourth week there were no stamens visible on any plants in these treatments, but numerous stigmas were still exserted. All fertile plants in the other treatments continued to flower in a normal manner, producing numerous stamens.

Flowering was not affected by the photoperiods within the temperature treatments. Exsertion of stamens stopped at the same time in the 8-, 10-, and 24-hour light periods at 10°C. In all other temperature-photoperiod treatments, exsertion of new stamens continued during the treatment period of 8 weeks. Normal-appearing stigmas developed on all plants in all treatments throughout the entire period.

Flowering behavior of the male-sterile strain did not appear to be altered in any way by any of the treatments. Stigmas but no stamens emerged under all temperatures and photoperiods.

Plants of both strains receiving continuous light developed shoots with long internodes and few branches; thus the total number of inflorescenses per plant was lower than for plants under the 8- and 16-hour photoperiods.

Pollen sterility was nearly complete in the male-sterile strain regardless of treatment. Anthers were flat, containing only shrunken nonstaining pollen grains. As shown in Table 1, anthers from male-fertile plants grown at 27° and 21°C days to 10°C nights contained high percentages of stainable pollen. These percentages are comparable to those observed in field grown plants during summer.

Anthers on short filaments, removed from plants grown at 10°C, contained a much lower percentage of stainable

Table 1. Appearance of florets, after 4 weeks of treatment, in fertile *P. clandestinum*.

Day length (hr)	Stamens	Fertile pollen (%)
Temperature 27°C		
8	Exserted	89 ± 16
16	Exserted	65 ± 11
24	Exserted	71 ± 13
Temperature 10°C		
8	Nonexserted	36 ± 5
16	Nonexserted	21 ± 6
24	Nonexserted	0.4 ± 0.2
Temperature 21°C (day) to 10°C (night)		
8	Exserted	72 ± 13
16	Exserted	82 ± 16

pollen than in the other treatments. Thus, there was a decrease in pollen fertility associated with the nonexsertion of anthers in the low temperature treatment.

Photoperiod did not affect the degree of pollen fertility at the warmer temperatures. However, at 10°C, pollen fertility decreased as the photoperiod increased. Under continuous light, sterility was essentially complete.

Seasonal sterility in *P. clandestinum* therefore appears to be influenced primarily by low temperature. The interaction of long photoperiod with low temperature to increase sterility is difficult to relate to the natural seasonal sterility.

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20 October 1960

Hemoglobin Types of Macaca irus and Macaca mulatta Monkeys

Abstract. Hemoglobin of 30 *Macaca mulatta* monkeys and of 15 *Macaca irus* monkeys consisted of one electrophoretic component similar to human hemoglobin A. Twenty-one *M. irus* monkeys had two types of hemoglobin. In 20 animals the hemoglobin resembled human hemoglobin AJ, and in one animal it resembled human hemoglobin AI.

While studying the hematological effects of irradiation in animals, we examined the blood and bone marrow of 36 adult monkeys of the species *Macaca irus* (cynomolgus) and 30 of the species *Macaca mulatta* (rhesus). Hemoglobin was analyzed by paper electrophoresis at *p*H 8.6 with veronal buffer, 0.05 ionic strength (*1*), and the percentage of alkali-resistant hemoglobin was measured (*2*). Stained smears of blood and bone marrow were examined, and the packed-cell volume and percentage of reticulocytes were determined.

Hemoglobin of all the *M. mulatta* and 15 of the 36 *M. irus* monkeys resembled human hemoglobin A by electrophoretic analysis (Fig. 1). Hemoglobin of 21 (58 percent) *M. irus* monkeys consisted of two components similar to the human hemoglobin combination AJ. The electrophoretically slow component in our monkeys was designated type A, the fast component, type B. The predominant component was type A in some animals (type AB); in others it was type B (type BA), as shown in Fig. 1 and Table 1. The hemoglobin of one animal consisted of type A, and a second component which migrated more rapidly than type B and was designated type C (Fig. 1). The percentage of alkali-resistant hemoglobin ranged from 0.3 to 2.0 with no significant differences among the groups under study, although we did observe significant increments in the alkali-resistant fraction of hemoglobin in *M. mulatta* and *M. irus* animals with types A, AB, and BA hemoglobin after sublethal irradiation (*3*).

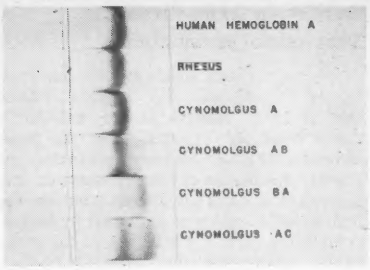

Fig. 1. Relative electrophoretic mobilities of hemoglobins as designated.

We found no evidence that the presence of B or C hemoglobins imposed a hematological handicap upon the carriers (Table 1). An examination of bone marrow aspirates obtained from the anterior iliac crest revealed no abnormality. There were no distinguishing morphological characteristics of erythrocytes in carriers of B or C hemoglobins. The sex of the animals was not correlated with the incidence of hemoglobin type B (Table 1).

The differences in hemoglobin types among different species of monkeys and among members of the same species have been described recently by others (*4–7*). The hemoglobin of six *M. irus* animals studied by Kunkel (*5*) by starch block electrophoresis had two electrophoretic components, one of which resembled human hemoglobin A. A fast component was present in concentrations ranging from 25 to 65 percent of the total hemoglobin. Lie *et al.* (*4*) performed paper electrophoretic analysis of the hemoglobins of a total of 116 *M. irus* animals obtained from different areas of Indonesia. Forty-three percent of monkeys from one area and 73 percent of those from a second area had two types of hemoglobin. The electrophoretic mobility of the hemoglobin from animals with a single component was similar to human hemoglobin A. The second component migrated more rapidly than type A. The predominant fraction of hemoglobin in some cases was the fast component; in others, the slow component predominated. Although different methods of paper electrophoretic analysis were employed, we believe that the hemoglobin types A and B described by Lie and her co-workers (*4*) are, respectively, the same as the types A and B which we have found.

The occurrence of type B hemoglobin in the absence of type A hemoglobin in *M. irus* has not been reported, despite the relatively high incidence of hemoglobin AB in the series of Lie *et al.* (*4*) and in our series. These findings suggest the following possibilities: (i) Synthesis of hemoglobins A and B is controlled by allelic genes and the combination of BB is lethal in the early life of the affected animal. (ii) Prevalence of hemoglobin B results from a state of balanced polymorphism, analogous to the high incidence of hemoglobin AS and the low incidence of hemoglobin SS disease in adults in some areas of Africa (*8*). (iii) Genes responsible for synthesis of hemoglobins A and B are nonallelic, similar to the nonallelism of genes controlling hemoglobins A and G in the human being (*9*).

Hemoglobin type C appears to be quite rare in *M. irus* since it was encountered only once in our series and in none of the animals studied by Lie *et al.* (*4*). The type C variant is similar to the fast component found by Jacob and Tappen (*6*), in a monkey of the species *Cercopithecus mitis*, which

Table 1. Hemoglobin types of *M. irus* and *M. mulatta* monkeys.

Hemoglobin type	Animals (No.)	Sex		Range and mean (%)	
		M	F	Packed cell volume	Reticulocytes
	M. irus				
A	15	9	6	34–47 (40.6)	0.1–4.3 (0.8)
AB	11	7	4	35–45 (40.3)	0.2–1.1 (0.7)
BA	9	4	5	39–45 (42)	0.3–1.3 (0.7)
AC	1	1	0	42	1.0
	M. mulatta				
A	30	19	11	36–47 (40.9)	0.2–2.3 (0.87)

is electrophoretically similar to human hemoglobin I.

Since we have not yet compared our two-component hemoglobins with those reported by Kunkel, and because of the differences in electrophoretic methods employed, it is not possible to definitively relate his findings to ours (*10*).

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19 October 1960

Loss of Mass in Echo Satellite

We wish to make a correction to our report, "Perturbations of the orbit of the Echo balloon" [*Science* **132**, 1484 (1960)]. In preparing a detailed description of our theoretical method we discovered an error in sign in our expression for the third (and higher) harmonics of the earth's gravitational potential. (We used the coefficients provided by an astronomer, but with the physicists' definition of gravitational potential which, as we now know, is precisely the negative of that used by astronomers.)

According to our published results, the third harmonic caused a decrease in eccentricity of about -3×10^5 per day during the first 12 days after launch. The magnitude of this decrease is approximately one tenth as large as the increase due to solar radiation pressure. However, despite its being so small, it affected significantly our attempt to estimate the reflection properties of the balloon and the rate of its loss in mass due to gas escaping from puncture holes. In order to reconcile the theoretical with the observational changes in eccentricity, we had assumed that the value of KA/M (the product of a scattering constant and the area-to-mass ratio of the balloon, defined in our report) increased substantially from its nominal initial value of 102 cm²/g.

After correcting the sign in the third (and higher) harmonics, we now find that for the first 12 days the values of KA/M which lead to reasonable agreement with the observed changes in eccentricity are quite close to 102 cm²/g. For example, by assuming specular reflection ($K = 1$) and a decrease in mass of 0.6 lb/day, our theoretical predictions of the changes in the eccentricity from its initial value agree with changes deduced from observations to within 2 percent at all points. (The corresponding probable errors associated with the data range from 1 to 2 percent, except for the first two days after launch when the absolute changes were quite small.) On the other hand, by assuming specular reflection and no loss in mass, we find that after 12 days the predicted change in eccentricity is 4 percent below the observed change. (With respect to the argument of perigee, close agreement with the data is obtained in both cases.)

These differences between eccentricity changes estimated with an assumed loss in mass of 0.6 lb/day and changes estimated with no loss in mass do not conclusively establish that a detectable amount of gas escaped from Echo during this short period. Other physical phenomena about which little is known (such as variations in the solar constant) could also account for these differences.

Of course, since Echo was launched more than 3 months ago, many more data on its orbit have now accumulated. We find that the assumptions that K equals 1 and that loss in mass is 0 lead to changes in eccentricity which are 10 percent below those observed at the end of this extended period. Hence, it appears reasonably certain that by now Echo has lost a measurable portion of its gas. Preliminary attempts at adjusting the changes in KA/M to obtain close agreement with the data indicate that the rate of loss in mass decreased after Echo entered the earth's shadow.

The rather slow escape of gas from the balloon (slow as compared with the rate predicted by many before launch) may provide valuable information on the micrometeorite environment in the vicinity of Echo's orbit.

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* Operated with support from the U.S. Air Force.

19 December 1960

Chromosomal Control of Preferential Pairing in Nicotiana

Abstract. A stock of tobacco with 23 pairs of tobacco chromosomes and one substituted pair from *Nicotiana glutinosa* was available. An amphiploid of this tobacco with *N. tomentosiformis* was synthesized in order to test whether preferential pairing is determined by the homologies of the chromosomes or whether it is under genic control. Characteristically, segregates for duplex loci in *N. tabacum* × *N. tomentosiformis* amphiploids give a gametic output of about 3:1, but for a factor on the substituted chromosome that output was found to be 59:1. The result suggests that preferential pairing in this material is not genically determined.

My co-workers and I (*1*) have used genetical segregation of synthetic amphiploids to measure differential affinity (*2*) of chromosomes. Since in any particular amphiploid the segregation ratios for independent factors were often found to be of similar magnitude, it became desirable to ascertain whether preferential pairing is determined, in our material, by individual chromosome homologies or whether it is under genic control. In the latter case, all chromosome sets of four would exhibit a similar degree of differential affinity, and would give similar genetic ratios, while under the former condition loci on different sets of chromosomes might give very different ratios.

Holmes Samsoun tobacco is an appropriate stock for such a test. In this variety Holmes (*3*) had substituted a pair of chromosomes from taxonomically distant *Nicotiana glutinosa*, which carried a dominant gene for resistance to mosaic disease, for a pair of tobacco chromosomes. The stock has been maintained over the years by selfing, and a recent test proved that it still contained 23 pairs of tobacco chromosomes and one pair from *N. glutinosa* (*4*).

The other parent for the synthetic amphiploid was *N. tomentosiformis*. This species is related to *N. tabacum* and is perhaps the closest living relative of that cultigen (*5*). Amphiploids *N. tabacum* × *N. tomentosiformis* have given consistently very small segregation ratios, indicating a close homology of the chromosomes of the two species and absence of differential affinity.

In general, an amphiploid which has obtained the recessive allele from one of its parent species and the dominant allele from the other may be symbolized as being of the genetic constitution *ZZzz*. If there is no differential affinity, the testcross of such an amphiploid will produce phenotypic ratios lying between 5:1 and 3.7:1, depending on the extent to which double reduction occurs. In *N. tabacum* × *N. tomentosiformis*

Table 1. Segregation of amphiploids *N. tabacum* × *N. tomentosiformis* for mosaic resistance in testcrosses to susceptible tobacco.

Plant No. of amphiploid	Seeds sown (No.)	Necrotic reaction	Mottled reaction	Died
	Amphiploid Holmes Samsoun × N. tomentosiformis			
C 113–4	90	58	0	1
C 113–13	90	33	2	1
C 113–15	180	98	2	1
C 113–23	90	47	0	0
Totals	450	236	4	3
	Amphiploid Burley 21 × N. tomentosiformis			
B 51–9	270	41	0	2

amphiploids, ratios ranging from 2.3:1 to 4.7:1 were obtained for six loci on five different chromosomes. These results did not suggest any differential affinity, though thus far it could not be satisfactorily explained why the ratios were all smaller than 5:1 and mostly even smaller than 3.7:1 (*5*). On the other hand, *N. tabacum* × *N. glutinosa* amphiploids gave ratios of about 80:1 for two independent loci (*6*), which were attributed to the effect of pronounced differential affinity at meiosis.

Thus, the chromosomes of *N. tabacum* and *N. tomentosiformis* appear to be closely homologous while those of *N. glutinosa* differ. The question to be asked is this: will the mosaic resistance factor of Holmes Samsoun give as small a segregation ratio as the other factors in amphiploid *N. tabacum* × *N. tomentosiformis*, or, alternatively, will the *N. glutinosa* chromosomes, in which the resistance factor is located, exhibit a behavior all their own?

To test this problem four amphiploids *N. tabacum* (Holmes Samsoun) × *N. tomentosiformis* were used. They had been produced by the treatment of germinating seedlings for 3 hours with 0.12 percent aqueous colchicine; the seeds came from a single capsule of a cross between Holmes Samsoun tobacco and *N. tomentosiformis*. A fifth amphiploid had been made in the same way with Burley 21 tobacco which carries mosaic resistance in a relatively small *N. glutinosa* segment in a chromosome of *N. tabacum* (*4*). The amphiploids were testcrossed to nonresistant tobacco. When the progeny plants had reached a diameter of approximately 2 in., their leaves were brushed with tobacco mosaic virus suspension. The inoculation was repeated one to several times at weekly intervals until each plant showed clearly either the localized necrotic lesions caused by the presence of the "resistance" factor from *N. glutinosa* or the mottling symptoms with which nonresistant tobacco responds.

The results are shown in Table 1. Out of a total of 240 scored plants, four did not contain the resistance factor—that is, the ratio was 59:1 in the backcross progenies from the Holmes Samsoun × *N. tomentosiformis* amphiploid. Unfortunately, the seed from the backcross of the amphiploid Burley 21 × *N. tomentosiformis* germinated poorly, and only 41 plants were obtained from 270 seeds. All of these had the resistance factor.

The data suggest that the low segregation ratios reported previously (*5*) for amphiploid *N. tabacum* × *N. tomentosiformis* are determined by the individual chromosomes and are not characteristic of the amphiploid per se. The *N. glutinosa* chromosome introduced into the *N. tabacum* complement behaved in a specific manner.

The result obtained from the amphiploid with Burley 21 was perhaps surprising, because here the resistance factor was carried in a chromosome which was in part *N. tabacum*; in a previous paper (*4*) it was suggested that the *N. glutinosa* sector in this interchange chromosome was less than an arm. Yet this chromosome exhibited pronounced differential affinity through the absence of segregation (Table 1, bottom). Because of the small family which was obtained the result could not be exploited quantitatively.

It may be argued that the possibility of genic control of differential affinity has not been disproved. One may propose that the particular *N. glutinosa* chromosome used could have contained a factor with such an effect. Simultaneous segregation for mosaic resistance and some independent factor could be used to test this point. Unfortunately, in the progenies of Holmes Samsoun × *N. tomentosiformis* amphiploids no other segregations could be scored. However, the Burley 21 × *N. tomentosiformis* amphiploid segregated also for the burley (white stem) character as reported elsewhere (*5*) and gave in a testcross 36 green and 16 burley plants. This result was in striking contrast with the 41:0 segregation ratio for mosaic resistance obtained from the same amphiploid but similar to other segregation ratios from *N. tabacum* × *N. tomentosiformis* amphiploids (*5*). Therefore, an association of a gene controlling differential affinity with the resistance factor is unlikely.

Recently a genetic system has been described in hexaploid wheat which effectively suppresses pairing between homeologous chromosomes (*7*). Thus there exists in wheat what amounts to genetically controlled preferential pairing which insures meiotic regularity. Since the subgenomes of *Triticum aestivum* share considerable homologies, such genic control was presumably favored early during the evolution of the species (*8*). In the evolutionary history of *Nicotiana tabacum* such mechanism was not required since amphiploids between species of the ancestral types already exhibit fairly regular bivalent pairing (*9*). The present study did not reveal the existence of genic influences upon preferential pairing; but only genes which reduce its amount could have been discovered in the present experiment—with the exception of the *N. glutinosa* segment in Burley 21 in which genes with the opposite effect could have made their influence felt (*10*).

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3 October 1960

On Antimatter and Cosmology

Abstract. A cosmological model based on a gravitational plasma of matter and antimatter is discussed. The antigravitational interaction of matter and antimatter leads to segregation and an expansion of the plasma universe. The expansion time scale is controlled by the aggregation time scale.

There have been speculations recently about the possible large-scale existence of antimatter in the universe and the relation between such postulated existence and physical theory (*1–8*).

The present position seems to be as follows: (i) Elementary particle theory indicates a complete symmetry in the production of particles and antiparticles. (ii) It is generally argued that we live in a universe of matter alone because great annihilation energy would be observed if appreciable antimatter existed and there were no segregation mechanism. (iii) "Antigravity" segregation would not be consistent with the general theory of relativity.

General approaches to the question of the coexistence of matter and antimatter on a large scale in the universe have been two. First, the general theory of relativity is given preference over the symmetry of production of matter and antimatter (*6*), and (ii) is accepted. A second approach has been to assume that the production of matter and antimatter is—and was at every epoch—symmetric, but that annihilation is prevented by a segregation mechanism. A statistical fluctuation segregation mechanism has been considered by Goldhaber (*1*) but a further analysis does not support it (*7*). A second segregation mechanism considered by Goldhaber is that of an initial segregation through decay of a self-conjugate universon into a cosmon and an anticosmon which were the precursors of our universe and an unobservable antiuniverse (*1*).

Still another proposed segregation mechanism is that of "antigravity," whereby it is supposed that there is mutual repulsion between matter and antimatter and mutual attraction between all bodies of the same type matter (*3*, *4*, *8*). Morrison (*4*) considers a mixture of the two types of matter interacting in this way and calls such a mixture a gravitational plasma.

The purpose here is to discuss an evolving cosmological model based on matter-antimatter symmetry and antigravitational segregation. While general relativity may be supposed valid in any region occupied by one type matter alone (*3*), it would not apply to the gravitational plasma as a whole; therefore, a Newtonian system will be considered (*9*). The basis of this model is a "neutral" gravitational plasma in which the bodies all have the same inertial mass at any epoch; it is assumed that the bodies may grow by aggregation or agglomeration.

In the first place, it has been noted that a gravitational plasma has properties which are significantly different from those of an electric plasma (*4*). Besides these we consider that each charged body in a neutral electric plasma has a positive binding energy because the dominant interaction is with its nearest neighbors, to which it is attracted. On the other hand, in a "neutral" gravitational plasma each body is repelled by its nearest neighbors and possesses a negative binding energy. Thus, besides being unstable to segregation and aggregation, a neutral gravitational plasma is unbound.

From these considerations, a gravitational plasma universe, of itself, flies apart. It is tempting to associate this unbinding with a cosmic repulsion (*10*) leading to recession of the galaxies. Consider a Newtonian gravitational plasma spherically symmetric about an origin of coordinates (*9*). For all epochs, the concentrations of matter and antimatter will be supposed equal in the large. For simplicity we do not consider the detailed internal dynamics of the plasma but, as usual, assume the interior of the sphere to be uniformly filled with the plasma. The kinetic pressure is also assumed to be zero. If we follow these assumptions, and neglect velocity dispersion at the boundary (*11*), the evolution of the plasma is described by the radial motion of the boundary bodies. The bodies on the boundary experience a net radial force and a radial acceleration. If, for ease of computation, the bodies are assumed to be distributed regularly on a three-dimensional cubic lattice, the radial acceleration of a boundary body is (*12*)

$$\ddot{R} = C\frac{m}{a^2} = C\left(\frac{3M}{4\pi m}\right)^{\frac{2}{3}}\frac{m}{R^2} = C\left(\frac{3M}{4\pi}\right)^{\frac{2}{3}}\frac{m^{\frac{1}{3}}}{R^2} \qquad (1)$$

where C is a constant, m is the body inertial mass, R is the plasma radius, and M is the total inertial mass. This assumes that R is much larger than the body separation or 'lattice parameter," a.

On this basis one might visualize the evolution of this model as follows. At the beginning of the expansion the finite radius gravitational plasma universe is at rest relative to the coordinate origin and is in a state of relatively high density and low aggregation (small R, small m). Because of the small body mass, m, the plasma expands very slowly—resembling a slow expansion from a static Einstein universe—the rate of aggregation effectively controlling the expansion. Aided by instability against segregation and aggregation (*4*), stars and antistars are formed while over-all neutrality is maintained by the randomness of aggregation sites.

As aggregation proceeds, m and R increase, and acceleration of the expansion proceeds as a competition between aggregation and expansion dilution. The expansion is always accelerated, however, and after a sufficiently long time the gravitational plasma universe is flying apart at a high rate and all bodies are receding from any body well inside the plasma (*9*).

For such a model universe, departure from a smoothed-out universe forms an essential part of its dynamics; an ideally smoothed-out universe of this type would expand only through annihilation radiation or an initial radial velocity. Another important feature is that the expansion time scale is not independent of the aggregation time scale.

An interpretation which might be made is that the present epoch in our universe is to be identified with the epoch in this model universe at which clustering of galaxies and of antigalaxies has taken place, but at which there is yet no appreciable clustering of clusters and of anticlusters (*13*).

This is admittedly very hypothetical, but on the other hand there are observations interpreted by some (*14*) to indicate an apparent noninteraction of clusters which might be understood on the basis of such a model.

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10. This cosmic repulsion is of a different nature from the usual cosmic repulsion in that it does not vary directly with radius and in that it depends on boundary effects.
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24 October 1960

Observations on the Sexual Stage of Colletotrichum orbiculare

Abstract. An isolate of the fungus *Colletotrichum orbiculare* (syn. *C. lagenarium*) race 1 that forms perithecia in culture was isolated from edible gourd in North Carolina. This isolate has been identified as a species of *Glomerella*. The isolate produces very few ascopores when selfed; however, ascospores are produced in abundance when mated with certain other isolates of *C. orbiculare*.

An isolate of the cucurbit anthracnose fungus *Colletotrichum orbiculare* (syn. *C. lagenarium*), originally cul-

tured in 1959 from edible gourd, variety Cucuzzi, (*Lagenaria leucantha* var. *longissima*) in North Carolina, has formed the perfect stage when the cultural techniques for mating fungi described by Nelson (*1*) were used. Perithecia contained very few mature ascospores when selfed, although when they were paired in combination with certain other isolates of *Colletotrichum orbiculare*, ascospores were produced in abundance. Progeny ascospore isolates also produced fertile perithecia. Pathogenicity studies with the original isolate and with ascospore progeny cultures indicated that the gourd isolate is of the type described by Goode (*2*) as *C. orbiculare* race 1.

The sexual stage of *C. orbiculare* has been reported previously only twice. Stevens (*3*) induced cultures of *C. orbiculare* to produce perithecia by the use of ultraviolet radiation. These perithecia contained asci but did not form mature ascospores. He described this perfect stage as *Glomerella lagenarium*. Because Steven's isolate did not form mature ascospores, the proposed name *G. lagenarium* for the cucurbit anthracnose fungus has not been generally accepted. Watanabe and Tamura (*4*) observed perithecia in cultures of an anthracnose fungus isolated from infected cucumber (*Cucumis sativus*) leaves. They named their isolate *Glomerella lagenaria*. In a monographic study of the genus *Colletotrichum*, von Arx (*5*) considered *C. orbiculare* as a specialized conidial form of *Glomerella cingulata*. Von Arx also showed that the specific name *Colletotrichum lagenarium* (the binomial used almost exclusively in the literature) was improper. After reviewing the papers of Berkeley (*6*), we agree with von Arx that the taxon *C. orbiculare* has priority for the asexual form of this fungus.

The perfect stage of the North Carolina isolate has been identified as a species of *Glomerella*. Preliminary comparisons of the North Carolina isolate with the isolate of Watanabe and Tamura and with several isolates of *Glomerella cingulata* have been made. The North Carolina isolate of *Glomerella* differs from *G. lagenaria*, as described by Watanabe and Tamura, in growth rate, colony morphology, presence of setae, conidial color, and pathogenicity. The only similarities are in conidial shape and size. Morphologically the sexual stages of both organisms fall into the broad description given for *G. cingulata*. However, the exact taxonomic relationships of these isolates have not been established. Studies are in progress to clarify the taxonomic position of the North Carolina isolate of *Glomerella* and to determine its genetic relationship to the previously described races of *Colletotrichum orbiculare* (*C. lagenarium*) (*7*).

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24 October 1960

Evoked Cortical Potentials in Absence of Middle Ear Muscles

Abstract. Evoked potentials to click at auditory cortex were recorded from cats deprived of middle ear muscles. Variations in the amplitude of the response after surgery indicate that the participation of these muscles in habituation, conditioning, and distraction must be minimal.

Lability of evoked potentials to auditory stimulation has been demonstrated at various auditory and nonauditory loci in habituation, conditioning, distraction, and extinction (*1*). It has also been demonstrated that middle ear muscle action not only contributes to sound attenuation at the periphery of the auditory mechanism—for example, at cochlear round window (*2*)—but that these muscles may and do participate in central phenomena such as conditioning (*3*).

Hernández-Péon *et al.* (*4*) showed that electrical responses to clicks in the dorsal cochlear nucleus of the cat are depressed during attentive behavior. They attributed this attenuation to a reticular influence which controls sensory transmission at the first synapse, presumably by way of efferent paths.

Hugelin *et al.* (*5*) took exception to this neural mediating mechanism and suggested that the lability observed at the cochlear nucleus may be adequately explained by contractions of middle ear muscles. They showed in the curarized "encéphale isolé" cat (muscles inactivated) that reticular stimulation has no effect on the amplitude of the dorsal cochlear nucleus response to click. Furthermore, in normal cats deprived of middle ear muscles on one side, reticular stimulation attenuated cochlear nucleus potentials on the normal but not on the operated side. From this they suggest that the middle ear muscles are responsible for the amplitude reduction at cochlear nucleus in the normal cat.

The present study was undertaken to determine whether evoked potential lability at the auditory cortex of normal cats could be entirely accounted for by middle ear muscle contraction. Four

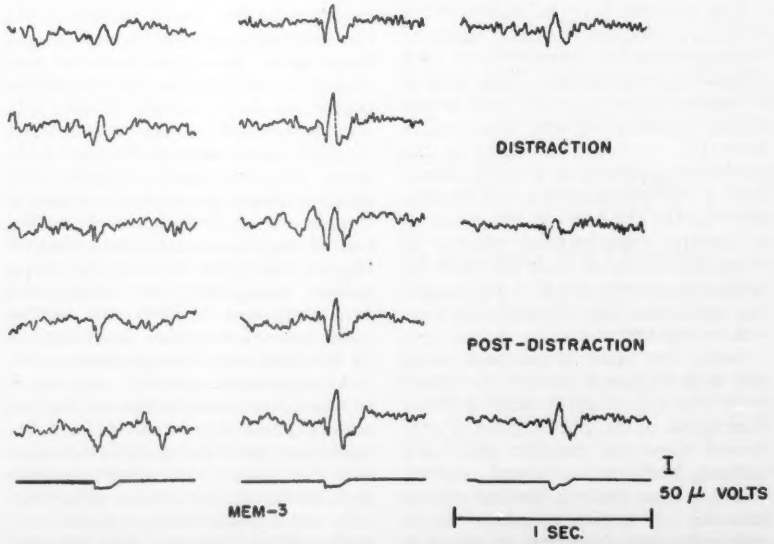

Fig. 1. Electrical responses to click at auditory cortex during habituation, conditioning, and distraction.

cats were prepared under anesthesia as follows. The stapedius and tensor tympani muscles were cauterized bilaterally. Then recording electrodes were implanted on both cochlear round windows as well as upon the auditory cortex (A_1) of one side. A day or so after the operation, the cats were placed in a cage located in an electrically shielded sound-attenuated experimental room and "habituated" by exposure to clicks of moderate intensity delivered at a rate of one click per 10 seconds day and night for at least 10 days. Complete electroencephalographic recordings, as outlined below, were made on three animals with a Grass model IIId electroencephalograph located adjacent to the experimental room.

Figure 1 illustrates five successive click-evoked cortical potentials taken from one typical cat in the "habituated" state. Soon after this habituated sample was collected, the animal was conditioned by reinforcing selected clicks with a puff of air directed to its face. Figure 1 clearly shows enhancement of the evoked potentials produced by this reinforcement. The number necessary to produce such marked changes in evoked potentials varied with the animal, but in all three cases, fewer than five puffs produced the "conditioned" changes apparent in the figure.

In three cats amplitude measurements were made on 25 successive responses taken during both the habituated and the conditioned periods, and their means were compared by t tests. For each of them, the increase in size of the conditioned evoked potential was significant beyond the .0001 level.

Soon after the conditioned tracings were obtained, the experimenter visually distracted the cat during the delivery of one click by standing at the open door of the laboratory. The last column of Fig. 1 shows the tracings obtained immediately before, during, and after distraction.

Successful removal of the middle ear muscle attachments to the ossicles was verified in two ways. First, the round window response to tone bleeps ranging in frequency from 500 to 5000 cy/sec delivered through earphones is in normal animals reduced in amplitude by middle ear muscle contraction within 15 to 20 msec of its onset; this reduction did not occur in the animals in this series. Second, at autopsy the muscles on both sides were found to have been severed in each cat.

Thus, our data show that in cats without middle ear muscles the variations seen in evoked potentials at the auditory cortex during habituation, conditioning, and distraction closely resemble what is seen in an unoperated animal subjected to the same procedures. Any participation of the muscles in producing these response amplitude variations must therefore be minimal (*6*).

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25 October 1960

Gamma Globulin (Gm group) Heterogeneity in Chimpanzees

Abstract. The serum gamma globulin (Gm) serological system was examined in 24 chimpanzees. Five Gm a, Gm b, and Gm x phenotypes, including Gm (a—b—x—), were observed. Phenotype did not appear to be related to serum gamma globulin concentration. The presence of the Gm system in apes suggests that this polymorphism in man is balanced and ancient.

The various genetic polymorphisms found in human blood are of uncertain antiquity. An estimate of the age of any one polymorphism may be obtained by examining the blood of other animals. Application of this principle to the serum gamma globulin (Gm) polymorphism (*1*) is the object of the present investigation.

Serum gamma globulin typing is based upon neutralization by normal serum of an indirect Coombs type reaction occurring between selected sera from patients with rheumatoid arthritis (RA) and type O Rh+ erythrocytes sensitized with certain incomplete anti-Rh sera. Allelic specificity is usually conferred by selecting an anti-Rh serum which possesses the allelic product being typed (*2*, *3*) and an RA serum which lacks this product (*4*). Gm^a, Gm^b, and Gm^x are apparently allelic in man. Gm^a and Gm^b are co-dominant with the result that three phenotypes and corresponding genotypes are distinguishable. The phenotype Gm (a—b—) has not been observed except in individuals with agammaglobulinemia. The Gm (a—b—) phenotype has not been observed by us during typing of more than 2000 healthy people.

Table 1. Ranges of Gm classification scores in chimpanzees.

Allele	RA dilutions employed	Control scores (saline)	Phenotype		
			Gm+	*Gm^I	Gm−
Gm^a	1/2–1/1024	33–36	0	–	31–36
Gm^b	1/4–1/64	16–20	0–4	8	12–17
Gm^x	1/8–1/128	17–18	0	–	12–20

* Intermediate.

Sera from 24 chimpanzees (*5*), 2 gibbons, 25 cynomolgous monkeys, 2 rhesus monkeys, 2 spider monkeys, 1 red monkey, 4 domestic cows, and 5 mongrel dogs were examined. Sera were absorbed overnight in the cold with nonsensitized O Rh+ cells. Without absorption all but chimpanzee sera produced moderately to strongly positive nonspecific reactions. After absorption all sera were diluted 1/8 and tested. The method of examination was that described by Harboe (*2*). RA serum dilutions employed for typing Gm^a, Gm^b and Gm^x are given in Table 1.

The chimpanzee was the only species whose sera inhibited any of the Gm typing reactions. Agglutination scores (*6*) were obtained, and these, together with the resulting phenotype distinctions, are shown in Table 1. Scores were repeatedly confirmed for each animal. The observed numbers of animals with various Gm^a and Gm^b phenotypes are given in Table 2. Only one animal of 22 tested was Gm (x+), being also Gm (a+b+). The single instance of an intermediate score occurred in the Gm^b system, and this animal was arbitrarily classified as Gm (b—).

Fourteen of the chimpanzees were affected with extensive pulmonary tuberculosis. The frequencies of Gm phenotypes in this group differed slightly from those observed in healthy animals (Table 2). These differences were not a manifestation of altered amounts of gamma globulin (*7*), since the concentration of serum gamma globulin, estimated by the product of gamma proportion found on paper

Table 2. Gm classification of 24 chimpanzees.

Presumed genotype	Phenotype	Total	Tuberculous	Normal
Gm^a/Gm^a	Gm (a+b−)	1*	0	1*
Gm^a/Gm^b	Gm (a+b+)	11	8	3
Gm^b/Gm^b	Gm (a−b+)	10	5	5
−/−	Gm (a−b−)	2	1	1

* Intermediate Gm^b score.

electrophoresis and total protein by the biuret method, did not appear to influence Gm phenotype. In 21 animals (11 tuberculous and 10 healthy) gamma globulin concentrations and Gm[a] type were determined on the same serum aliquots. The upper limit of the gamma globulin concentration for Gm (a−) individuals was 4 times the lower limit observed among Gm (a+) individuals. The mean gamma globulin concentration was 1.50 g/100 ml among the Gm (a+) animals and 1.60 g/100 ml among the Gm (a−) animals. Several animals with Gm (a+b+) phenotype had smaller concentrations of gamma globulin than the two chimpanzees with Gm (a−b−x−), that is, "Gm-less" phenotype. The single Gm (a+b+x+) individual had a gamma globulin concentration of 2.01 g/100 ml. This was exceeded by the gamma globulin concentrations of three other animals, two of which were Gm (a−). The individual with an intermediate Gm[b] score had a gamma globulin concentration of 0.54 g/100 ml. Lack of correspondence of gamma globulin concentration with Gm phenotype is in accord with observations in man (*7*). Such findings suggest that the Gm substances are specific proteins rather than a variable feature of all gamma globulins. Further evidence for this view is provided by the failure of large increases in gamma globulin, after immunization of chimpanzees with ovalbumin, to alter either a Gm (a−b−x−) or a Gm (a−b+x−) phenotype.

Our results confirm the earlier observation of Podliachouk (*8*) who found that of various animals studied the chimpanzee alone possessed the Gm (a+) character. All of 24 chimpanzees examined were Gm (a+). Reagents for typing other allelic products were not then available. The universality of the Gm (a+) character in the earlier study may be the result of inbreeding in small ape isolates.

The appearance of Gm polymorphism in both man and chimpanzee might be due to two independent sets of mutation resulting in at least three similar allelic products in two species. A simpler explanation would be to assume a common origin for the polymorphism in which case the system probably originated at least as early as the Oligocene period. If the latter explanation is correct, then it, in turn, indicates that the polymorphism in both species is balanced rather than transient and subject to rather ubiquitous selective forces.

The observation of heterogeneity of specific gamma globulins which are common to man and chimpanzee suggests a possible means of demonstrating in man the allotype described by Oudin (*9*) and others (*10*) in rabbits. The chimpanzee may be useful as a surrogate man for the purpose of creating isoprecipitins which can then be tested against human sera for reaction with isoantigens. Such an attempt is currently in progress (*11*).

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6. Agglutination with each RA dilution was scored on a scale of 0–4. Complete neutralization by animal serum results in a score of 0 and classification as Gm+.
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21 November 1960

Fossil and Living Conchostracan Distribution in Kansas–Oklahoma across a 200-Million-Year Time Gap

Abstract. Fifty-nine of 493 ponds sampled in the Wellington fossil conchostracan belt contained *Cyzicus mexicanus* (Claus). Persistent habitat preference and faunal association were also found for four orders of insects (Odonata, Ephemeroptera, Neuroptera, and Homoptera). Comparative limnology is detailed. Greater geographic fractionation of Permian conchostracan gene-pools is attributed to a more arid climate indicated by evaporites.

For the past 3 years, as part of a paleolimnological research project, one of us (P.T.) has been tracing the conchostracan-bearing beds of the Wellington formation (Permian, Leonardian) of Kansas and Oklahoma (*1*). It occurred to him that a survey of living clam shrimp distribution in the entire area of mapped Wellington conchostracan-bearing beds might provide useful information for comparison. Accordingly, Zimmerman was assigned to the project as limnologist-entomologist. Well over 550 ponds were sampled during the summers of 1958 to 1960. Collecting during 1958–59 was sporadic, and only during June, July, and August of 1960 was systematic and persistent daily sampling carried out. It is this last sampling of 493 ponds that is reported on here.

Of 493 ponds sampled in and near the Wellington outcrop belt [Fig. 1, Table 1, and (*2*)], 59 contained clam shrimps. An over-all percentage of 12.1 percent of all ponds sampled contained clam shrimps, the range being from 6.4 percent to 16.4 percent.

Weather records (*3*) show that, for the belt of investigation, average temperatures and rainfall were similar for the 3-year sampling period.

The conchostracan, *Cyzicus mexicanus* (Claus), was the only species present in all collections. It was found to be presently distributed, though more irregularly, in the same general area as the Wellington fossil-conchostracan beds. A persistence of habitat-preference from Paleozoic time to the present has thus been demonstrated. In fact, several ponds bearing clam shrimp were discovered *within* the outcrop belt of fossil occurrences (Marion County line, northern Kay County, northwest Noble County; see Fig. 1).

In addition, most other clam shrimp ponds were found to be adjacent or proximate, or both, to such outcrop belts. A few exceptions were noted. Most present-day clam shrimp ponds in southern Dickinson County, for example, occur to the north and east of the fossil belt in this region. The relatively rugged topography in the fossil belt compared to the low-lying terrain to the north and east may account for this distribution (*4*).

Modern ponds in the sampled area were found to possess very specific characteristics. Alongside of these, fossil occurrences in the Wellington will be cited.

Duration of modern ponds is relatively short. In fossil occurrences, conchostracans found on any given bedding plane are separated from younger and older occurrences by rock intervals ranging from millimeters to meters. Hence, we may conclude that Leonardian ponds, like modern ones, were temporary and sporadic in occurrence.

Currents are generally absent in modern ponds. This is also true of Leonardian ponds. However, there is some evidence of microcross-bedding due to currents in clam shrimp-bearing argillaceous limestone. Similarly, highly fossiliferous cross-bedded siltstones were found.

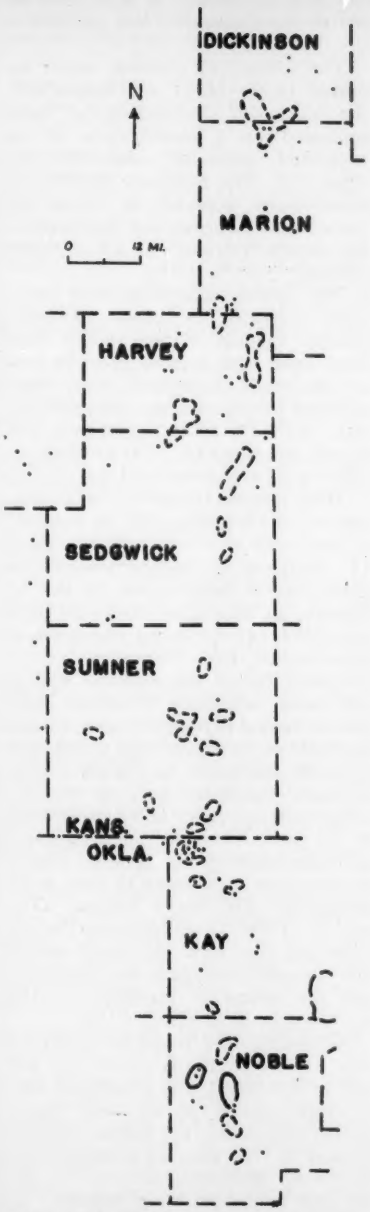

Fig. 1. Distribution of the living conchostracan, *Cyzicus mexicanus* (Claus), in the outcrop belt of Leonardian (Wellington) fossil conchostracans. Dashed lines embrace area of fossil clam shrimp localities (data by Tasch). Solid line (Noble County) embraces fossil clam shrimp localities (data by Raasch) explored but not sampled by Tasch. Dots represent localities of ponds bearing *C. mexicanus* (data by Zimmerman). Isolated dots to west of Sedgwick and Harvey counties are clam shrimp-bearing ponds that parallel some of the Ninnescah formation clam shrimp beds. Drafting by Bernard Shaffer (assistant to Tasch in fossil collections).

The bottom of modern ponds consists of soft clay mud, often mixed with gravel. In fossil occurrences, the lithology of clam shrimp-bearing beds was most often argillaceous limestone. Indurated red, green, and gray clay muds and siltstones also bore fossil conchostracans at specific localities.

The depth of modern ponds is generally less than 12 in. In fossil occurrences, the depth is also generally very shallow. In one instance (many could be cited to illustrate the basis for this conclusion), a thin fissile shale 0.2-foot thick bore 25 distinct clam shrimp generations completely separated from each other by an interval of sediment 1.0 mm to 5.0 mm thick.

Turbidity was found to be present in all but two of the modern ponds containing clam shrimps. This turbidity was due to clay mud in suspension. In fossil occurrences, turbidity may be inferred by the frequently appearing indurated clay muds containing fossil clam shrimps and by the highly argillaceous composition of clam shrimp-bearing limestones which are extremely fine-textured.

Modern ponds have indefinite margins, probably due to depression of the strandline during drying. In fossil occurrences, there are numerous small irregularly shaped bio- and lithofacies bearing clam shrimp fossils that have been mapped. One instance of an actual three-dimensional pinch-out of a wedge-shaped body bearing clam shrimps was found.

Modern ponds are generally barren of submergent or emergent vegetation with the exception of allochthonous materials. By far the most common situation in fossil occurrences is the absence of all vegetal debris. In some portions of the Wellington, however, there were abundant plant debris, carbonized and silicified wood, whole logs (autochthonous), and leaves. Charophytes and spores are also found in some clam shrimp beds.

In modern ponds, a mud margin of several yards generally intervened between the water and encircling vegetation. In fossil occurrences, clam shrimp valves abounded in some mud-crack beds. This conforms to field observations of the mud margins of some modern ponds studded with conchostracan shells.

Modern ponds are small, approximately 500 ft^2. In the Wellington, many clam shrimp found as fossils occupied puddle-sized water bodies. Several instances of occupancy of larger water bodies as well were indicated when it was possible to sample for fossil conchostracans laterally for many hundred feet.

Modern ponds were found in open fields, roadside ditches, sloughs, and flood plains. While details are still to be worked out, the picture that emerges for the Wellington is of a series of relict ponds and puddles in a coastal swamp area where the sea occasionally invaded. This last conclusion is indicated by the occurrence of algal reefs over and below clam shrimp-bearing beds and by related data.

Table 1. Distribution of modern conchostracan-bearing ponds in a seven-county area embracing mapped outcrop belts of the Permian Wellington conchostracan beds (sampled during June, July, and August 1960).

Region*	Total No. of ponds sampled	No. of ponds containing clam shrimps	Total No. of sampled ponds bearing clam shrimps (%)
I	73	11	15.0
II	79	13	16.4
III	91	6	6.5
V	78	5	6.4
VI	101	16	15.8
VII	71	8	11.3
Total	493	59	12.1 (av.)

* I, Dickinson County, Kan.; north and central Marion County, Kan.; II, southern Marion County, Kan.; Harvey County, Kan.; III, Sedgwick County, Kan.; V, Sumner County, Kan.; VI, Kay County, Okla.; VII, Noble County, Okla.; Region IV embraced sampled ponds in Reno, Harper, and Kingman counties, Kan., but it is not included since it parallels the outcrop belt of the Ninnescah shale (9). Of 47 ponds sampled in this region, 11 bore clam shrimps.

Modern ponds have a *p*H ranging from neutral to slightly alkaline. Ponds with reducing conditions do not contain clam shrimps. In fossil occurrences, an equivalent *p*H seems to have prevailed in most instances. However, the finding of fossil conchostracans in green shales (formed under reducing conditions) and the presence of organic debris that could yield humic acids indicate some reducing condition in Leonardian bottom muds of the mapped area. In such events, clam shrimps probably migrated to the upper reaches of the water. Aquarium populations of *Cyzicus mexicanus* raised by one of us (P.T.) were found to behave in this way when bottom muds were fouled. In general, living clam shrimps, and presumably fossil forms during their lifetime, require well-aerated waters.

No clam shrimps were found in brackish waters of modern ponds. No salt flats were observed in dried-out modern ponds. By contrast, gypsum, salt casts, and casts of hopper crystals—some very large—were not infrequent in Wellington clam shrimp-bearing beds (*5*).

In was found that four of the several orders of insects (Odonata, both damselflies and dragonflies; Ephemeroptera, mayflies; Neuroptera, lacewings; and Homoptera, leaf hoppers) that were fossilized with Wellington conchostra-

cans (*6*) were also present in or on the surface of modern clam shrimp ponds in the sampled area. In this instance, as with the conchostracans, it is clear that habitat-preference and adaptation which were established or operative in Leonardian time still persist.

While the fossil collections have yet to be thoroughly analyzed for clam shrimp populations, certain observations, based on field and laboratory notes are possible at present. A one-species spread such as that for *Cyzicus mexicanus* seems, at any given time, to have characterized only portions of the Leonardian outcrop belt in Kansas and Oklahoma. Thus, one of the oldest clam shrimp zones, some 10 feet above the Annelly gypsum, contained three different generic types: pemphicycliids (bearing a tubercle or spine on the initial valve), typical estheriids (lacking valve structures), and, at one Oklahoma locality, leaiid conchostracans (bearing two ribs on the valve). Or, in Kansas localities, three related but distinct genera were found in contemporaneous beds: *Pemphicyclus* (initial valve with central minute tubercle), *Gabonestheria* (large anterodorsal conical spine on initial valve), and *Curvacornutus* (with large anterodorsal, looped or hooked spine on initial valve). Multiple instances of this kind of differentiation (speciation) in contemporaneous ponds could be cited (*7*).

Thus, the fossil record in the mapped area (Fig. 1) indicates a greater incidence of genetic variability at specific times and at several different times of clam shrimp appearance during the Wellington. In turn, this refers to a more frequent geographic fractionation of the common gene pool with attendant reproductive isolation and speciation in Leonardian situations than is found in modern ponds in the sampled area. The evaporites noted earlier denote a more arid climate with consequently greater alternation of drying and wetting. This might well be a critical factor in the "more frequent geographic fractionation" referred to above (*8*).

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2. Constructed farm ponds are not included in this sample.
3. Data were obtained from the U.S. Weather Bureau, Wichita, Kan., for the years 1957 through June 1960. The belt of investigation lies in and occupies most of the 30–35 in. rainfall zone.
4. The spotty distribution of *Cyzicus mexicanus* in the sampled belt recorded during the 1960 sampling confirms field observations made during the less intense collecting of the summers of 1958 and 1959. During the 1960 field season, some areas that contained no clam shrimp ponds in June or July were re-explored during the early weeks of August. Of 35 such ponds sampled, clam shrimps were found in four, or in 11.4 percent of the total sample. This figure confirms the 12 percent over-all average (Table 1). Thus, while a few more scattered clam shrimp ponds might be located by continued visitations to the same areas, it is unlikely that the over-all average will be importantly increased.
5. Data on faunal associates, multiple generations per season, special cases, and so forth, are too detailed for inclusion and analysis here.
6. P. Tasch and J. R. Zimmerman, *Science* **130**, 1656 (1959).
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8. This is a progress report of a paleolimnological research project supported by National Science Foundation grant No. G-7320.
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15 August 1960

Metabolism of Adrenaline after Blockade of Monoamine Oxidase and Catechol-O-methyltransferase

Abstracts. Experiments in cats infused with 5 μmole of *dl*-adrenaline-2-C^{14} showed that blockade of either monoamine oxidase or catechol-O-methyltransferase is largely compensated for by the activity of the intact enzyme system; combined blockade of both enzyme systems results in the formation of a new adrenaline catabolite and in the increased production of acidic, mainly conjugated, catabolites, the identity of which remains to be established.

Previous studies on the metabolism of adrenaline and noradrenaline have shown these hormones to be inactivated mainly by oxidative deamination and O-methylation (*1*, *2*). In order to evaluate more fully the role of monoamine oxidase (MAO) and catechol-O-methyltransferase (COMT) in the inactivation of adrenaline and noradrenaline, the work described below was undertaken.

Cats anesthetized with Nembutal were infused over a 5-minute period through a cannula in a femoral vein with 5 μmole of *dl*-adrenaline-2-C^{14} (specific activity, 1.25 μc/μmole) dissolved in physiological saline. The animals were killed 5 minutes after the infusion. Blood, heart, liver, and kidneys were removed, homogenized in 10 percent trichloroacetic acid, and stored at −15°C until assayed. After the homogenates were filtered on a suction flask, the residue was extracted three times more by homogenizing in 5 percent trichloroacetic acid and filtering. The combined filtrates were then extracted three times with ether to remove the acid. The residual ether was evaporated *in vacuo*, and a sample of the aqueous solution was taken for determination of total radioactivity. The remainder was concentrated in a rotating flash evaporator at 35°C, and the *p*H of the concentrate was adjusted to 6.8.

The radioactive products which appeared in the blood and tissues after the infusion of *dl*-adrenaline-2-C^{14} were separated by a modification of the procedure previously described for urine (*2*). The metabolic pattern was much more complex in blood and tissues than in urine, and resolution of the various fractions was not as clearly defined.

The various catabolites were essentially identified by paper chromatographic analysis of the various fractions, with and without previous acid or enzymatic hydrolysis, with three different solvent systems: butanol saturated with 1*N* HCl; isopropanol, ammonia, and water (8:1:1); and butanol, acetic acid, and water (4:1:1).

Table 1 shows the pattern of metabolism of *dl*-adrenaline-2-C^{14} in controls; in cats after treatment with iproniazid (*3*) (100 mg/kg, intraperitoneally, 24 hours and 4 hours prior to the infusion); in cats after treatment with pyrogallol (*4*) (150 mg in 30 ml of physiological saline, intravenously) immediately before the infusion; and in cats after combined treatment with iproniazid and pyrogallol (same doses). It should be mentioned that at this time it is not our intent to present mathematically significant data on the distribution of adrenaline and its catabolites in the various tissues, but to present semiquantitatively the general aspects of adrenaline metabolism to serve as an orientation for future studies. The data in Table 1 are discussed in the sense that they show the major metabolic changes undergone by adrenaline and the effects of inhibition of the enzyme systems involved.

Adrenaline was found to disappear very rapidly from the blood and, except in one instance, it constituted only a small fraction of the total radioactivity recovered. The highest concentrations of free adrenaline occurred in the liver. Metadrenaline was by far the most important basic fraction. In some cases an additional, hitherto unidentified, basic catabolite was found having an R_F value slightly less than that of adrenaline in butanol and 1*N* HCl.

Among the neutral and acidic catabolites, peak 1 of Table 1 has been tentatively identified as a mixture of 3-methoxy-4-hydroxyphenylethylglycol, 3,4-dihydroxyphenylethylglycol, and possibly conjugates of metadrenaline and adrenaline; peak 2 is still unidentified; peak 3 is 3-methoxy-4-hydroxymandelic acid; and peak 4 is 3,4-dihydroxymandelic acid. Peak 5 is a mixture of various fractions; there is evidence that

Table 1. Distribution of radioactivity after intravenous infusion of *dl*-adrenaline-2-C^{14}. Figures are percentages of total radioactivity isolated from each tissue. Peak 1 represents 3-methoxy-4-hydroxyphenylethylglycol, 3,4-dihydroxyphenylethylglycol, and possibly conjugates of adrenaline and metadrenaline. Peak 2 represents an unidentified compound. Peak 5 represents a mixture of conjugates of both the glycols and both the mandelic acids.

Treatment	Control			Iproniazid		Pyrogallol			Pyrogallol and iproniazid		
					Blood						
Adrenaline	4	*	3	1	1	2	2	*	1	54	8
Metadrenaline	23	*	18	29	15	1	*	*	1	7	2
Peak 1	12	13	18	34	43	15	5	15	14	5	10
Peak 2	7	9	8	7	7	7	20	26	18	5	13
MOMA	11	13	7	4	1	4	3	9	3	2	3
DOMA	1	*	*	*	1	3	5	13	10	1	6
Peak 5	27	28	24	18	10	48	40	32	31	7	32
					Heart						
Adrenaline	9	1	7	1	2	3	2	1	*	37	7
Metadrenaline	44	15	22	56	35	2	*	1	*	5	2
Peak 1	4	11	17	6	8	12	7	17	14	7	17
Peak 2	*	11	3	6	7	7	7	26	9	2	21
MOMA	3	13	3	3	3	4	7	6	10	2	7
DOMA	*	*	3	4	2	7	13	4	9	2	8
Peak 5	2	28	18	11	12	26	44	27	33	10	30
					Liver						
Adrenaline	1	6	9	16	19	21	13	16	51	56	49
Metadrenaline	27	45	44	64	40	9	2	9	14	3	5
Peak 1	30	14	16	1	*	1	3	3	4	16	3
Peak 2	2	1	*	10	12	15	8	10	1	4	2
MOMA	11	7	4	*	*	1	1	3	*	4	1
DOMA	12	*	4	*	*	11	8	8	*	5	*
Peak 5	24	18	14	*	*	2	*	21	1	13	2
					Kidney						
Adrenaline	2	1	4	1	1	6	9	1	4	46	6
Metadrenaline	36	36	14	76	52	4	1	1	2	7	1
Peak 1	7	8	34	8	14	36	*	23	18	3	16
Peak 2	2	*	*	3	2	2	30	28	22	4	18
MOMA	7	4	3	2	1	2	*	8	3	3	5
DOMA	*	4	*	*	2	1	*	5	4	*	5
Peak 5	23	41	20	*	8	19	*	30	26	3	30

* Less than 1 percent.

they are conjugates of both the glycols, and both the mandelic acids just mentioned.

In the untreated animals more than 70 percent of the recovered radioactivity in the blood was found in the neutral and acidic fractions; in the heart, liver, and kidneys, 50 percent of the recovered radioactivity was found in these fractions. In the blood, kidney, and heart, 60 to 70 percent of the radioactivity in the acidic and neutral fractions was accounted for as 3-methoxy-4- and 3,4-dihydroxyphenylethylglycol, and the mixture of conjugates. The two mandelic acids, and the unidentified compound in peak 2 represent the remaining radioactivity.

Treatment with iproniazid or pyrogallol or both increased the amount of total radioactivity recovered in the blood and heart but did not noticeably alter the total radioactivity in the liver and kidneys.

The principal effect of treatment with iproniazid was to increase the amounts of metadrenaline in all of the tissues; only in the liver was there a marked increase in the amounts of adrenaline. Concomitantly, the amounts of 3-methoxy-4- and 3,4-hydroxymandelic acid and of the mixture of conjugates were decreased. It is noteworthy that treatment with iproniazid did not significantly influence peak 2, which suggests that the substance corresponding with this peak is not a product of monoamine oxidase activity.

Treatment with pyrogallol markedly decreased the metadrenaline content of the blood and tissues. The adrenaline contents of the kidneys and liver were increased—in the latter, to about the same extent as that after treatment with iproniazid. The mixture of the conjugates is markedly enhanced in the blood and heart but, on the average, is lowered in the liver and kidneys. The mixture of 3-methoxy-4- and 3,4-dihydroxyphenylethylglycol was decreased in the liver but was not significantly different from the controls in the heart, blood, and kidneys. The fact that peak 2 was found unchanged or increased in these circumstances suggests that it is also not a product of catechol-O-methyltransferase activity.

Combined treatment with iproniazid plus pyrogallol provoked a very marked decrease of methylated catabolites. The amounts of adrenaline found in the liver were markedly higher than in the controls; in the other tissues, only in one of the three instances was the level of adrenaline highly elevated. The metabolism of *dl*-adrenaline-2-C^{14} mainly consisted in the increased production of the catabolite corresponding with peak 2 and in the formation of a new unidentified basic catabolite with an R_F value slightly less than that of adrenaline in butanol and 1*N* HCl. This alternate catabolite occurs mainly in the liver, where it may represent as much as 35 percent of the total radioactivity. In one animal this pathway also appeared to be the most important in the heart and kidneys. In the two other animals, however, this did not occur, and the metabolism of adrenaline apparently consisted in the enhanced production of acidic, mainly conjugated, catabolites, the identity of which remains to be established.

The results of the studies reported here indicate two major alternative pathways—oxidative deamination and O-methylation—and two minor pathways—conjugation and an unidentified reaction—for the metabolism of adrenaline in the cat. In the heart, both monoamine oxidase and catechol-O-methyltransferase appear to be present in sufficient amounts to compensate for decreased activity on the part of one or the other of the enzyme systems. In the liver, inhibition of either one of the enzymes results in a decreased rate of metabolism of adrenaline; however, as in the heart, inhibition of either monoamine oxidase or catechol-O-methyltransferase is largely compensated for by the activity of the other enzymes capable of metabolizing adrenaline. In the kidney, inhibition of monoamine oxidase is completely compensated for by catechol-O-methyltransferase activity, whereas inhibition of catechol-O-methyltransferase is not completely, but is to a very large extent, compensated for by the activity of monoamine oxidase and other enzymes (*5*).

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1 August 1960

Meetings

Bionics

The unities underlying the behavior of animals, men, and machines were brought into clearer focus at a national symposium held 13–15 September 1960 in Dayton, Ohio. The meeting, under the sponsorship of the Wright Air Development Division of the United States Air Force, was attended by approximately 700 persons. Thirty invited speakers reported new developments concerning methods of information handling used by living systems and artificial models of such systems. The magnitude of the recent advances so impressed the participants that they virtually demanded that such a meeting be made a regular event. This report is based entirely on my notes; I apologize for any errors of fact or interpretation, and for not mentioning many talks because of lack of space.

At the start, H. E. Savely of the Air Force Office of Scientific Research pointed out three aspects of living systems which are worthy of study for incorporation into artificial systems: (i) the extreme sensitivity of certain receptor organs—for example, the ability of certain fish to detect a change in the electric field in the water around them of as little as 0.003 μv/mm; (ii) the ability of even simple living brains to integrate the activity of many sensor and effector organs; (iii) the ability to retrieve information rapidly in the central nervous system; and (iv) the ability to store information at molecular levels, even for periods of generations, as in the chromosomes. An example of the successful use of a living system as a prototype for an artificial system is the application in an optical ground-speed indicator for airplanes of the simple principle in the beetle's visual system that provides information on velocity.

H. E. Savely cautioned (i) that as long as we lack fundamental understanding of the laws of organized complexity, it may not be possible to duplicate the living system; (ii) that nature is limited simply to building on and modifying pre-existing systems and that the living system therefore may not provide the most economical approach to a particular information-handling problem; and (iii) that it is common for the physical scientist to think that he can take a quick look at some biological system, work out the principles in a very short time, and then apply them to the design of some artificial system. Not only is he mistaken in this belief but he is very much like Brer Rabbit attacking the Tar Baby. The harder he attacks the problems of biology the more deeply does he become enmeshed, so that he soon finds himself unable to drop them.

An analysis of the relatively simple servomechanism controlling the size of the pupil of the human eye was presented by Lawrence Stark, now of the Massachusetts Institute of Technology. This paper and one other were the only reports dealing directly with the information-handling mechanisms of living systems—evidence perhaps of the difficulty of such an approach. The other talks dealt with the design of artificial systems. E. E. Loebner of RCA Research Laboratories pointed out that man, because he has few outputs (muscles), has built only a few information inputs into the gear he controls, to match his few outputs. This restriction on the number of inputs has been carried over into equipment not under human control. It would often be preferable to give such equipment multiple inputs, such as man has in his sense organs.

The general logical operations that a computer must perform in order to behave like an organism were described by Peter M. Kelly of Aeronutronics. It must take inputs from a sensory field, code them into groups, act on them by some internal logic, code the outputs, and carry out responses in terms of this output code. The coding of the sensory input to the internal logic can be fixed in advance—that is, preorganized. It is also possible to design machines which are self-organized—that is, capable of learning how to code their sensory input and their output so as to achieve the desired responses to particular sensory situations. Kelly, and also Walter Reitman of Carnegie Institute of Technology, discussed the design of such machines and gave examples of existing machines in which the two types of design are used. (Could it be that when we intuitively judge one type of organism to have more "consciousness' than another, the distinction in physical terms is that it has a greater capacity for self organization?)

W. P. Tanner of the University of Michigan argued that the human being is not completely preorganized so as to give a fixed response for a particular sensory input but is capable of self-organization. Therefore, the human being subjected to psychophysical tests should not be considered to have a sensory threshold but should be treated as a computer which is testing the statistics of the test situation and making decisions which optimize some aspect of that situation. Tanner is analyzing such performances of human beings in auditory test situations.

The problem of designing a machine which can differentiate or recognize one out of all possible sensory functions was discussed by Seymour Papart of the National Physical Laboratory, Teddington, England. The problem is simplified by the fact (i) that the input functions possible are only a portion of all functions, and (ii) that as the number of dimensions of the input functions increase, the chance of separating any two input functions increases, even with a simple machine. He has roughly estimated that one human being during his lifetime could learn up to 10^8 particles of information. This much learning could be handled by any of the systems of self-organization described at the symposium. (Compare this estimate with the estimate of 10^{15} made some years ago by W. S. McCulloch and of 10^{13} to 10^{16} made by H. von Foerster.)

Artificial devices which recognize patterns, including one device capable of recognizing cancerous cells under the microscope, were mentioned by P. Metzelaar of Space Technology Laboratories. Some machines have given performance superior to the human—for example, a checker playing program for the IBM 704 computer. Other machines have been designed that can predict the future of a sequence from its past. Metzelaar suggested that if the design problems can be solved, the future machine will do preliminary pattern transformations on its sensory inputs in order to reduce the amount of information that must be handled and stored. It will also be able to consider its sensory input in either gross outline or fine detail and know which type of consideration is needed, decide how to divide its attention among its different sensory inputs, and know which of various recognition mechanisms it should use.

In a talk that was as remarkable for its witty asides as for its lucid exposition, A. Novikoff of Stanford Research Institute briefly described integral geometry and illustrated its use in the

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design of pattern-recognizing devices. One theoretical device is able to distinguish patterns, regardless of their rotation or translation in the visual field, by differences in the frequency with which the lines of the pattern were intersected by a line segment, of fixed length, repeatedly placed in random orientation and position on the visual image (a "randomly tossed" curve).

Visual Systems

J. R. Singer of the University of California described a visual system which, by means of radial scanning, can recognize a two-dimensional object regardless of the visual angle it subtends or of its rotation in the visual field. However, this system requires that the object be centered in the visual field, so it is unlikely that the visual systems of living organisms, at least of vertebrates, use the same principle.

A different type of artificial visual system, designed by L. D. Harmon of Bell Telephone Laboratories, can recognize the convexity of a moving target. It consists of seven similar photocells, six tightly packed around the central one. The output of the central photocell produces inhibition at an artificial neuron; the output of the others, excitation. The neuron responds only to the passage of targets with radii within a particular size-range, according to the threshold setting. This system may correspond to the convexity detectors in the frog's eye, previously reported by Lettvin, Maturana, McCulloch, and Pitts.

E. E. Loebner demonstrated an artificial visual system consisting of a matrix of photoconductors, each connected in series with an electric energy source and an electroluminor. When light hits a photoconductor, this permits current to flow through the luminor and causes the luminor to emit light. By appropriate connections and interconnections of these elements it is possible to reproduce many of the functions of the vertebrate retina, including all four detection functions found in the frog retina by Lettvin *et al.* It is possible that some of the circuits used in the model may be recognized in the living retina.

A machine capable of distinguishing among the spoken names of the digits ("one," "two," and so on) was described by W. C. Dersch of International Business Machines Corporation. At least one of the principles on which it operates is known not to be used in the human auditory system. L. A. de Rosa of International Telephone and Telegraph Corporation presented a theory of the operation of the auditory system, explaining that its frequency discrimination is produced by an autocorrelation process rather than by mechanical filters. W. A. van Bergeijk of Bell Telephone Laboratories has built an artificial neuron network which he considers analogous to the spiral innervation of the cochlea and has measured signal loss as a function of simultaneous firing of several branches of the neuron. No similar measurements have been made on the actual nerve for comparison. He has also built an analog of a branching sensory nerve of the skin and has found that the analog and such nerves have comparable recruitment functions.

Artificial Neurons

The highlight of the symposium was a group of talks by W. S. McCulloch and other mathematicians from his laboratory at the Massachusetts Institute of Technology and by K. K. Maitra of RCA Research Laboratories, on the general problem, "How simple can a neuron be and still, by proper interconnection . . . perform all the known functions of the brain?" They started with the very simple McCulloch-Pitt neuron, which consists of a device that has many inputs which can carry either excitation or inhibition. It possesses a polar threshold such that the output is in one or the other of two states, depending on whether the algebraic sum of the inputs does or does not exceed the threshold value.

M. Blum considered the general question of what logical functions could be performed by simple networks of such neurons. He showed that if the number of inputs (such as signals from different sense organs) to a neural net is large, the number of logical functions which the net can perform approaches one-quarter of the totality of logical functions. This should certainly be enough to perform the limited number of logical functions which are known to be carried out by the brain.

A. N. Verbeek showed how to produce reliable computation with a "noisy," unstable neuron having four sources of trouble: variations in the signal strength of the inputs, faulty connections, variations in internal threshold, and inability to propagate its output signal. He used triplet networks made up of three of the simple neurons, all the inputs to the triplet going in parallel to two of the neurons and their outputs going to the third neuron, whose output was the output of the triplet. Signals from each input were connected in parallel to each of many triplets. Each of these performs the logical operation, and the output of all the triplets goes to a neuron which acts as a majority decider, taking the outputs, comparing them, and deciding which is correct according to the output signals of the

majority. If each neuron is capable of producing an error 5 percent of the time, the upper limit of the probable error of such a net can be made less than one in 1 million by a combination of just 30 such redundant triplets. This work is of great significance, since up to now the only theoretical method of increasing reliability has been to put many elements in parallel wherever one element has been used in the original net. Von Neumann has shown that to achieve a reliability of one error in a million by this older method with neurons which produce an error 5 percent of the time would require a net of about 20,000 neurons.

Cowan presented the mathematical logic he has developed for dealing with the behavior of nets of neurons carrying on logical computations in the presence of noise. He was able to represent a general noisy computation scheme and to calculate the amount of signal that came through.

K. K. Maitra presented an extension of the work of Verbeek in the design of nets which reliably perform logical operations even though the neurons and connections of the net may be unreliable. He developed a simplified mathematical symbolism for describing the manipulations of each triplet network. He was able to show that where a certain logical function is desired from the triplet, this function can be achieved with the greatest reliability by making the triplet from a combination of neurons each having a particular logical function, determined by a process he could specify. In a similar way he was able to show that if triplets are combined into triplet networks and these in turn into larger triplets, and so on, a minimum probability of error is found in networks made by three or four orders of such tripletting. When instead of tripletting the triplets he duplexed them, this gave increasing reliability with increasing order of duplexing up to any arbitrary level of reliability. Thus, it is possible in theory to design networks with unreliable neurons which will give any desired reliability of performance.

In a delightful summarizing talk, H. von Foerster of the University of Illinois pointed out the importance of this work on reliability. It permits the achievement of increased reliability in a system not by increasing the reliability of the components and connections but, more economically, by multiplexing unreliable components.

At the end of the symposium a final question was presented to McCulloch. He was asked, in effect, whether the people working on information processing would not some day, like the nuclear physicists today, have cause to regret the social consequences of their

work. McCulloch replied that he was convinced that it was in man's nature to develop both the socially good and the socially bad consequences of any invention. He fully expects that the world will be booby-trapped by the use of these and other sciences, but it is his firm hope that by making available information-handling devices of great capacity man will prevent the detonation of that booby trap through misinformation.

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Forthcoming Events

March

19–25. Caribbean Region, American Soc. for Horticultural Science, 9th annual, Miami, Fla. (E. H. Casseres, Londres 40, Mexico 6, D.F., or W. H. Krome, Box 596, Homestead, Fla.)

20–22. American Physical Soc., Monterey, Calif. (W. A. Nierenberg, Univ. of California, Berkeley 4)

20–23. Institute of Radio Engineers, 1961 intern. convention, New York, N.Y. (E. K. Gannett, IRE, 1 E. 79 St., New York 21)

20–24. American Surgical Assoc., Boca Raton, Fla. (W. A. Altemeier, Cincinnati General Hospital, Cincinnati 29, Ohio)

20–24. National Health Council, forum and annual meeting, New York, N.Y. (NHC, 1790 Broadway, New York 19)

20–24. Western Metal Cong. and Exposition, 12th, Los Angeles, Calif. (A. R. Putnam, American Soc. for Metals, Metals Park, Ohio)

21–23. American Meteorological Soc., general meeting, Chicago, Ill. (E. P. McClain, Dept. of Meteorology, Univ. of Chicago, Chicago 37)

21–23. American Physical Soc., Division of High-Polymer Physics, 21st, Monterey, Calif. (D. W. McCall, Bell Telephone Laboratories, Murray Hill, N.J.)

21–23. American Power Conf., 23rd annual, Chicago, Ill. (W. C. Astley, Philadelphia Electric Co., 900 Sansom St., Philadelphia 5, Pa.)

21–24. American Assoc. of Anatomists, 74th annual, Chicago, Ill. (O. P. Jones, Dept. of Anatomy, Univ. of Buffalo, Buffalo 14, N.Y.)

21–30. American Chemical Soc., 139th, St. Louis, Mo. (A. T. Winstead, ACS, 1155 16th St., NW, Washington 6)

23–25. American Orthopsychiatric Assoc., 38th annual, New York, N.Y. (M. F. Langer, AOA, 1790 Broadway, New York 19)

23–25. Quantum Electronics, 2nd intern. conf., Berkeley, Calif. (J. R. Singer, Dept. of Electrical Engineering, Univ. of California, Berkeley 4)

23–26. International Assoc. for Dental Research, 39th annual, Boston, Mass. (D. Burrill, IADR, 311 E. Chicago Ave., Chicago 11)

24–29. National Science Teachers Assoc., Chicago, Ill. (R. H. Carleton, NSTA, 1201 16th St., NW, Washington 6)

26–29. American Assoc. of Dental

Schools, annual, Boston, Mass. (R. H. Sullens, 840 N. Lake Shore Dr., Chicago 11, Ill.)

27–31. Temperature—Its Measurement and Control in Science and Industry, natl. symp., Columbus, Ohio. (C. M. Herzfeld, National Bureau of Standards, Washington 25, D.C.)

30–1. Southern Soc. for Philosophy and Psychology, Atlanta, Ga. (D. R. Kenshalo, Dept. of Psychology, Florida State Univ., Tallahassee)

April

3–6. Massachusetts Institute of Technology, centennial celebration, Cambridge. (Office of Public Relations, M.I.T., Cambridge 39)

3–15. Medical Conference, 11th, Nassau, Bahamas. (Bahamas Conferences, P.O. Box 1454, Nassau)

4–6. Electromagnetics and Fluid Dynamics of Gaseous Plasma, intern. symp., New York, N.Y. (J. Fox, Microwave Research Inst., Brooklyn 1, N.Y.)

4–7. Society of Automotive Engineers, natl. aeronautic meeting, New York, N.Y. (E. W. Conlon and G. W. Periman, 485 Lexington Ave., New York 17)

4–8. National Council of Teachers of Mathematics, 39th annual, Chicago, Ill. (F. A. Janacek, J. S. Morton High School, Cicero 50, Ill.)

5–8. Water Relations of Plants, British Ecological Soc., symp., London. (F. H. Whitehead, Botany Department, Imperial College, Prince Consort Road, London, S.W.7)

6–7. Council on Medical Television, annual, Bethesda, Md. (Institute for Advancement of Medical Communication, 33 E. 68 St., New York 21)

7–8. Eastern Psychological Association, Philadelphia, Pa. (C. H. Rush, P.O. Box 252, Glenbrook, Conn.)

7–9. American Assoc. for Cancer Research, 52nd annual, Atlantic City, N.J. (H. J. Creech, Secretary-Treasurer, Inst. for Cancer Research, Fox Chase, Philadelphia 11, Pa.)

7–9. Fleming's Lysozyme, 2nd intern. symp., Milan, Italy. (R. Ferrari, Organizing Committee, Via Modica 6, Milan)

8–9. Histochemical Soc., 12th annual, Atlantic City, N.J. (H. W. Deane, Albert Einstein College of Medicine, Bronx 61, N.Y.)

9–13. American Assoc. of Cereal Chemists, annual, Dallas, Tex. (J. W. Pence, Western Utilization Research & Development Division, 800 Buchanan St., Albany 10, Calif.)

9–13. American Industrial Hygiene Assoc., Detroit, Mich. (W. S. Johnson, Bethlehem Steel Co., Bethlehem, Pa.)

9–15. American Institute of Nutrition, Atlantic City, N.J. (A. E. Schaefer, ICNND, Bldg. 16A, National Institutes of Health, Bethesda 14, Md.)

10–14. American Soc. of Civil Engineers, Phoenix, Ariz. (W. H. Wisely, 33 W. 39 St., New York 18)

10–14. Detection and Use of Tritium in the Physical and Biological Sciences, intern. symp., Vienna, Austria. (Office of Special Projects, U.S. Atomic Energy Commission, Washington 25, D.C.)

(See issue of 17 February for comprehensive list)

Letters

Drug Industry and Government

With reference to your recent "Science in the news" article [*Science* **132**, 1536 (1960)] commenting about government intervention in the drug industry, could it be that the author displayed just a little cynicism (which is perhaps too common these days) in saying: "There is the danger not of cordiality between the regulators and the regulated, which is useful, but of the regulators' coming to forget that, despite the room for a great deal of useful cooperation, the regulators and regulated do, or should, after all, represent opposing interests and opposing points of view"?

It does not seem to me that a really objective observer could conclude that the interests of the Food and Drug Administration and of the pharmaceutical industry are opposed. Rather, our interests are really identical: to provide the best medicine for those in need of it, or, putting it another way, to protect patients from bad medicine.

If the views of the industry and the government differ from time to time, I think such differences are largely confined to the question of how we attain our common objective. This may be a fine point, but it is one that is useful in the interests of clarity.

AUSTIN SMITH
Pharmaceutical Manufacturers Association, Washington, D.C.

DNA's and RNA's

In the realm of biochemistry, names (of substances) are used to designate products in which substantially all the molecules in a sample are the same, or at least potentially the same, through tautomerism. To speak of a *mixture* of structurally different molecules, as though they were all the same, causes misleading muddlement. The same principle holds for alphabetical abbreviations such as ATP, ADP, AMP, TPP, FAD, and TPN. For example, AMP stands for adenosine-5′-phosphate. If it were used indiscriminately to designate the 5′- compound, the 3′- compound, the 2′- compound, or the 2′, 3′- phosphate, this could only cause confusion.

A widespread violation of this principle, which can only result in confused thinking, particularly on the part of unsuspecting biology students, is the use of the designations DNA and RNA as though they, too, represent single species of molecules. This is particularly objectionable because there must be a multitude of DNA's and RNA's and

their biological functioning depends specifically upon the existence of a great diversity of molecules. To speak of *a* DNA or *the* DNA's is proper, but to refer simply to "DNA" as though it designated a chemical substance is unfortunate and leads to mixed-up thinking on the part of those who may not be fully initiated.

ROGER J. WILLIAMS
Clayton Foundation Biochemical Institute, University of Texas, Austin

Stimulus Generalization Gradients

In a recent report [*Science* **132**, 1769 (1960)] Eliot Hearst compares the stimulus generalization gradients obtained in the case of each of a concurrent pair of responses, one response being maintained by an appetitive reward, the other by aversive reinforcement. From his results he concludes that aversive reinforcement produces greater generalization (flatter gradient) than an appetitive reward. This conclusion is not warranted from the data presented because there is not even an attempt to equate the drive level corresponding to the two responses.

Since the earliest Pavlovian work it has been known that increased hunger (deprivation) flattens the generalization gradient of an alimentary conditioned reflex. Hearst could have readily manipulated the flatness of his appetitive gradient in this fashion. In the case of the aversively maintained response, the relevant drive variables are the intensity of the electric shock, the number of shocks received, and the time since the delivery of the last shock. Of these, the first is particularly significant. By decreasing the shock intensity in conditioning the avoidance response, a sharper gradient would have been obtained.

The equating of drive between positively and aversively reinforced habits is certainly unattainable in practice, and probably even in principle. Thus, Hearst's conclusions would in any case be questionable. The report would have had some factual value, however, if the deprivation schedule of the food-reinforced response and the electric shock parameters had been clearly described in the text. The absence of this information means that the data are not even reproducible by the noninitiated reader.

MICHAEL F. HALASZ
Department of Psychology, University of Chicago, Chicago, Illinois

I am glad to have the opportunity to make some additional comments on our stimulus generalization data and to answer several points raised by Michael Halasz.

1) Since appetitive and aversive

drives have quite different properties, any attempt to equate them would be very dubious. In my opinion this "obstacle" does not render futile or questionable all comparisons of appetitive and aversive behavior. A more positive approach to the problem might initially involve the design of a model situation in which both generalization gradients can be obtained, and then an analysis of the effects of various factors on the relative slopes of the two gradients. In our laboratories my co-workers and I are currently investigating such variables as type of avoidance and reward schedule, kind of response measured, visual versus auditory cues, method of testing, and amount of food deprivation to determine whether the reported results can be generalized to a wider variety of experimental conditions.

2) Extremely flat gradients of the sort reported for avoidance have rarely, if ever, been noted in prior investigations of appetitive drives, even with extremely high hunger motivation [for example, with subjects at 60 percent of normal body weight (*1*)]. In support of our avoidance findings, Sidman (*2*) has recently presented data which also indicate a very flat gradient for the type of avoidance behavior we studied; Sidman's results were obtained for an auditory dimension, and the two subjects were trained under different levels of shock.

3) It is not likely that shock parameters are extremely influential variables here. The monkey subjects rarely received more than one or two shocks per 2-hour session, and such factors as shock level, number of shocks, and time since preceding shock probably are important only in a situation where a meaningful number of shocks are received. In any case, it was noted in the report that no rewards or shocks were possible during generalization testing. Thus these factors could not have had a direct effect during the generalization tests sessions.

4) Halasz's assertion that decreases in shock intensity would have resulted in sharper avoidance gradients is rather premature, since there are very few experimental data bearing on this problem. As a matter of fact, Sidman (*2*) has recently shown that threefold changes in shock duration, though affecting response rate, have no effect on generalization. Additional experimental work is needed on this interesting problem, however.

5) The specific parametric values of the reported experiment are typical of those used in many current comparative studies of appetitive and aversive behavior—for example, in several productive investigations of differential drug effects on reward-motivated and fear-motivated behavior. Limitations of space made it impossible for me to include several details of the experimental method in the published report. The monkeys were maintained during the experiment on a daily diet of 60 to 70 Foringer D & G whole diet pellets, and each monkey was given one orange immediately after the session; the subjects had thus been food-deprived for approximately 22 hours at the beginning of each experimental session. Water was continuously available in their home cages. The shock level was set at an intensity of approximately 5 ma (0.6-sec duration), and shocks were delivered through a Foringer shock power supply and grid scrambler, which randomly reversed the polarity of the voltage on the grids. According to the animal's particular posture and movements at the time of punishment, the shock might vary by as much as 0.5 to 1.0 ma from the predetermined value.

ELIOT HEARST
Clinical Neuropharmacology Research Center, Saint Elizabeths Hospital, Washington, D.C.

References

1. D. R. Thomas and R. A. King, *J. Exptl. Psychol.* **57**, 323 (1959).
2. M. Sidman, *J. Exptl. Anal. Behavior*, in press.

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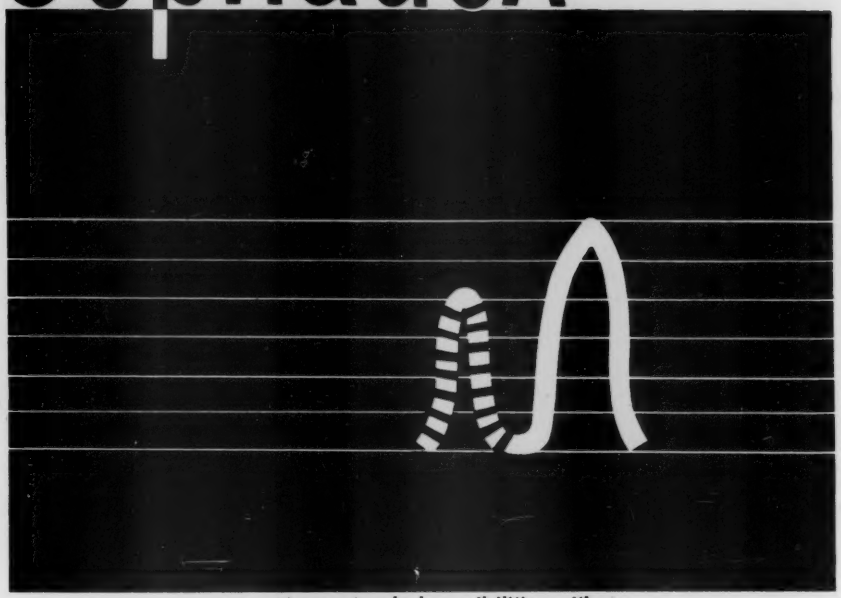

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